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SUBMISSION TO

THE ROYAL COMMISSION ON THE NORTHERN ENVIRONMENT

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November 19, 1982

130 ALBERT, OTTAWA, CANADA K1P 5G4 TEL: (613) 238-3525

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November 19, 1982

Mr. J.E.J. Fahlgren,
Commissioner,
Royal Commission on the Northern Environment,
55 Bloor St. West, Suite 801,
Toronto, Ont. M4W 1A5

Dear Mr. Fahlgren:

I have great pleasure in sending you, and to the Royal Commission on the Northern Environment, the outline of the Boreal Forest Symposium which was held in Thunder Bay in August of this year. This document is in response to the terms set out in the Letter of Agreement between the Royal Commission and the Association which you signed on the 30th September.

The package of material prepared for this Submission consists of three principal elements.

1. The Summary Account contains a narrative listing the principal themes and discussions in Thunder Bay. It has been written especially with a lay audience in mind and attempts to focus on the range of "bread and butter" issues which will be of interest and concern to people whose livelihood and lifestyle are principally derived from the forests of mid-Canada. The document is a report of the Proceedings and discussions and is not intended to advocate any particular approach or point of view.

2. The abstracts of the papers presented at the Symposium; a twenty-six page document giving, - in the authors' words - a short summary of each scholarly contribution. These are arranged in alphabetical order. Please note that there is, as well, an addendum of five pages giving additional abstracts. Some or all of these may be of interest to your staff and technical advisors.

3. We are also including a listing of the workshops, of the participants, and a variety of pre-conference documents which set out the purpose and organization of the Symposium.

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In our letter to you of the 2nd September we made the point that the Association of Canadian Universities for Northern Studies would not be making an "advocacy" submission to the Royal Commission. What is contained here is a report on the range of research now going on and which has a bearing on many of the questions before the Royal Commission. Should you wish to look into any of the matters in this report, we will, of course, be ready to lend every assistance to your enquiry.

All of which is respectfully submitted.

Yours sincerely,

David A.W. Judd,
Executive Director

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SUMMARY ACCOUNT

INTERNATIONAL SYMPOSIUM

ON THE

DYNAMICS OF BOREAL FOREST ECOSYSTEMS

FUTURE RESEARCH AND MANAGEMENT REQUIREMENTS

130 ALBERT, OTTAWA, CANADA K1P 5G4 TEL: (613) 238-3525

Summary Account

of
International Symposium
on the
Dynamics of Boreal Forest Ecosystems
FUTURE RESEARCH AND MANAGEMENT REQUIREMENTS

The symposium was held at Lakehead University, Thunder Bay, Ontario, 23-25 August, 1982. Participants numbered about 100 and included managers, academics, government officials and scientists, foresters, earth scientists, zoologists, botanists, and social scientists. Participants came mainly from Canada, but papers were also presented by specialists from the USA, Sweden and Finland.

The sessions on the first day were devoted to the presentation and discussion of papers that reviewed various aspects of the management of boreal forests. The participants were divided into 6 workshops for the second day during which they examined different parts of the whole question. The final day was a plenary session in which the conclusions and recommendations of the individual workshops were considered, and this summary account is our attempt to amalgamate and present the recommendations and reflections of this final plenary session. A full account of the proceedings of the symposium will be distributed later.

The 'boreal forest' comprises a multitude of forest biomes. In Canada alone the forest extends for some 8000 km from west to east and 1000 km or more from south to north. Management practices in one area may have little relevance to those in another, and it may well be that conditions in another province or another country are more significant for a resource manager.

Thus, interprovincial and international exchanges of information are essential for effective management. It was noted that the goal of management is to modify the forest to produce the maximum yield for the people in the region or country. Thus, the managed forest is not the natural forest.

The question that appeared to concern the participants the most was the communications gap between the research scientists and the managers responsible for the optimum harvest of the forest resources. Basic, curiosity-oriented research was seen to be essential, but research directed towards the broad base of the managers' problems was also important. This involved mainly the need for useable theories of biological dynamics within the framework of time and space needed by management. Managers, however, cannot defer decisions until the research is completed, but will have to continue doing the best they can on the basis of the information at hand. In effect, the scientists are shooting at a moving target, and the integration of research information in the process of making decisions is never-ending. The problem of feeding in that information must be solved, and nearly all comments related in some way to that problem.

Another concern of many participants was the lack of understanding of the forest resource as a whole - fibre, fuel, fur, fish, and fun. More and more people are using the forests as a place for recreation, and considerable numbers of native people still depend on the boreal forest for substantial quantities of 'country food', for fuel and for shelter. Thus many comments related to the need to regard the boreal forest as a dynamic ecosystem in which <u>all</u> components of the biomass are relevant to the harvest (i.e. not only the arboraceous component). Managers need some basis for quantifying the

economic potential of individual components, keeping in mind that some benefits, e.g. esthetic, cannot be given a monetary value. A multidisciplinary approach is more and more needed by managers, but traditional funding agencies are only now coming to grips with methods for funding such research. A recurrent topic in the symposium was the use of fire as a tool for managing forest resources. Since fire has traditionally been suppressed in the boreal forest, the idea of managing fire is a radical change in thinking. To manage successfully will call for a much more extensive information system.

It became pretty clear that participants considered that an ultimate objective of forest research is to aid management by providing a better understanding of the resource as a whole, and less globally, to provide managers with information on specific problems posed by them. The distinction between management and research tends to become blurred; in some cases they are indistinguishable.

MANAGER-SCIENTIST RELATIONS

Recommendations

1. Forest managers should ensure that their needs for broader and more integrated information are known to the scientific community.

Comments: Managers tend to ignore a large part of the information provided by scientists because the information tends to be on too small an area of the overall problem, and is often not directly relevant to a manager's concerns. Unless the manager makes his needs known

and encourages relevant work, the scientists will tend to do their own thing. Long-range forecasting on the development of the forest biomass, the capacity to modify stand architecture, and several other requirements were mentioned as examples of what the manager needs. In addition to the scientists who provide the knowledge base, other scientists are needed who can synthesize the results and work with the managers in using them to best advantage. It was also noted that great quantities of information are now readily available through computerized systems - e.g. CISTI (Canada Institute for Scientific and Technological Information), but that the outputs may not be in the form that managers need. If so, the reporting procedures could be modified to suit their needs.

2. Scientists who have had experience in research and who show a concern for management problems should be encouraged to develop a broader approach.

Comments: As they gain experience, some scientists become interested in synthesizing the results of research on a wide spectrum of subjects, and in attempting to evaluate the synthesis. From here it is only a short step to the application of this information to the problems of management, and it is this sort of individual who should be closely associated with resource managers. In effect, a manager of research could have a strong influence in bringing the results of research to the resource manager and in stimulating the kind of research needed to help the resource manager to get the

most out of the resource. Another way of reducing the communications gap, especially in smaller organizations, might be through working groups that include both managerial and scientific types. But that does not deny the need for university research scientists to get together to discuss where the knowledge gaps are, according to their perceptions, and thence to coordinate their research efforts to fill these gaps, in a systematic approach.

3. More effort is needed to ensure that managers have as much information as possible on all aspects of the forest domain - soil and sub-soil, total plant cover, hydrological regime, wildlife, people, and alternative uses.

Comments: Many of the participants tended to discuss the forest harvest as if it included only the trees, others as if it were mainly a source of 'country food', and others as if alternative or sequential uses depended on an adversarial approach. Wise decisions, however, will depend on knowledge of the dynamics of the whole biomass and the various uses to which the forest can be put, including recreation. Only then can intelligent appraisals be made on the economic benefits that may derive from different alternatives. Benefits that may not be quantifiable in economic terms, must not be neglected in arriving at decisions.

FIRE

The traditional management policy towards fire has been that of total suppression. However, there is an increasing awareness that fire is a natural component of boreal forest ecosystems. Thus the idea of fire management, as distinct from suppression, is gaining ground in all countries having boreal forests. In the fire management mode, attack is not taken on all fires; the fires are monitored and prescribed burning may be employed as well. The workshop participants did not make any formal recommendations that the policy of fire management be adopted, but rather wished to indicate what the managerial and research needs would be to operate in the fire management mode: a decision to monitor, rather than suppress, requires a much more sophisticated support system because the options for the manager are increased and their outcomes can have profound consequences not only for the flora and fauna of the forest, but also for other property. Currently available information is inadequate and more research is needed on the social, managerial, physical, biological, economic and historical aspects of fire management.

The manager must be able to show top management and political leaders that the risks are worth the gain; other users of the forest and those in adjacent jurisdictions must be convinced that they will lose nothing.

If fires are to be successfully managed, much more study must be given to improving the effectiveness of controlling fires;

Comment: Fire management includes not only the ability to prevent and suppress fires, but also capacities to predict, monitor and to prescribe the intensity of the burn. In order to develop adequate

models on the spread of fires under different conditions of weather and fuelwood, many matters need to be investigated: the historical record of fires caused by people; lightning strikes; fire detection methods; analyses of wildfires; resource allocation and effectiveness in fire suppression.

Social and biological systems that are put at risk by managed fires must be understood so that alternative possibilities can be evaluated.

Comment: Possibly the most important consideration is the way that society perceives the risk. To some extent this will hinge on the history of fires in the region, the techniques for suppression, and the type of forest being considered for burning. A good hypothesis for post-fire development is required - vegetative succession, the effect on wildlife, eventual harvest in different stages of development, including timber production, animal productivity, and recreation.

THE DYNAMICS OF BOREAL FOREST ECOSYSTEMS

If the boreal forest is to be managed successfully it is essential that its dynamics be understood. In engineering terms, the system is already running: what is needed is "systems discovery", i.e. we need to know how the system works.

In forest management, the basic unit is the stand. In order to come to

grips with the dynamics of the forest, the dynamics at the level of the individual stands must be understood. Thence, a forecast can be developed for the probable scenarios that would follow the implementation of any managerial options. To develop a forecast for the whole forest, all the stand forecasts must be integrated. Thus, an array of basic actions - scheduling and distribution of the harvest, renewal and protection of the resource - can be designed to produce any desired stage of forest development in the optimum time. Differently stated, there is a pressing need for theories of biological dynamics within the framework of the time and space constraints of management.

Finally, to enable the transfer of knowledge from one eco-region to another a classification system is needed. Ideally for managers this classification would be based on a system that permits identification of areas where the responses are similar to particular types of disturbances. Thus, this system would depend on the type of disturbance.

Recommendations

1. Considerably more research is needed into theories and hypotheses using biologically sound input. These will provide managers with models to aid them in the decision-making aimed at achieving the desired goal in forest productivity. Too often, failure to attain the goal has been due, not to bad decisions per se but to decisions based on incorrect, or insufficient data, or on inappropriate models.

2. Nutrient cycling is the key process influencing soil-nutrient availability and, therefore, forest production.

Comments: From such studies would come better understanding of the effects of different regimes. For example, where soils are coarse and nutrient-poor, the harvesting method can have marked effects on the nutrient pool, depending on whether it is conventional, or whole-tree removal, or clear-cutting; slash removal and disturbance by heavy equipment further affect the subsequent nutrient balance of the site. It was strongly urged that full-tree harvesting be restricted to areas where the soil is moderately deep, and is relatively rich in nutrients. Nitrogen supply is a limiting factor in much of the boreal forest: the nitrogen is often bound in the humus layer and its release is slow.

3. In order to understand better the possible succession of forest types in managed areas, existing information from permanent plots should be more fully analysed with regard to climate, soil, type and extent of disturbance.

Comments: The basic problem is how to modify the normal forest succession in order to get the best harvest. This involves test plots, experiments in spacing and thinning, types of harvesting, etc. All need to be integrated so that simple models can be made to capture the dynamics of the system.

4. So that knowledge of one eco-region can be correctly applied to a similar region elsewhere, an appropriate classification system must be developed.

Comments: A plethora of classification systems already exists. A more coordinated approach is needed, to derive a system applicable for managerial purposes throughout the boreal forest region. This would enable the manager to decide on land-use priorities for each region.

5. Surficial deposits, and the soils derived from them, should be studied geochemically to provide base-line data from which it is possible to determine the effects of pollutants.

Comments: Without such studies it will be impossible to determine the effects of emissions of heavy metals from industrial activities, or of acid rain. Background levels of heavy metals vary widely, especially in the Canadian Shield, so that the effects of added heavy metals can have different results. Acid precipitation can also accelerate the release of heavy metals from soils and rocks, especially significant where the concentrations of them may be of concern even without acid rain. The cumulative effects of acid rain are impossible to determine without adequate base-line data, and since the effects may take many years to manifest themselves, 'accelerated' simulation experiments are also needed so as to predict the long-term changes in the waters and soils of the boreal forest.

SOCIAL ISSUES

It is generally agreed that the effects on society of any managed natural resource are the most difficult to balance in the economic equation. Different groups of people see the same question in wholly different lights. Too often attempts at informed discussion are defeated by vociferous groups whose main aim seems to be to disrupt, and no solution was offered to the problem of how to have informed public participation under such conditions. The use of 'country foods' and the development of other animals for food could probably be substantially extended if prejudices were overcome, both social and legal. Similarly, alternative energy sources, especially the by-products from forestry, could be developed. The communication between the forest developers, whether of forest, animals, or mineral deposits, and the people who live in the region needs to be greatly improved.

Recommendations

1. An assessment is needed on the economic potential of using more food from the boreal forest.

Comments: The existing game laws might be modified to make the harvesting of game animals possible in Canada, as has been successfully undertaken in many countries. Management of game animals could result in greater numbers and better economic potential. It is possible that horses could be produced for meat, especially in the northern parts of the boreal forest, and that coarse fish species might be marketable.

2. More intensive investigations are needed on the uses of bio-energy in small northern communities.

Comments: In addition to studies on the bio-sources themselves, study on transportation and marketing, on the effects on communities, and on the economics of such change are needed. Fast-growing species of trees in higher latitudes would seem to be a worthwhile subject for further study. The utilization of peat merits technological investigation similar to that being done in other countries. The use of peat as a base for microbial protein and for fermentation processes should be intensified.

3. Funds should be allocated by development corporations as part of the project costs for determining base-line data and for following up during and after the project.

Comments: Amongst other things, critical environmental and social factors should be identified and a program for collection of base-line data begun well before the project begins. Since the natural fluctuations of environment and biomass extend over many years, collection of such data should begin as early as possible, but in no case should it be less than 2 years before start-up. Since many forest projects extend over thousands of hectares and periods of 60-80 years, the collection of "undisturbed" data and "modified" data can carry on for many years. For hydroelectric and mining developments the time to collect data from the undisturbed environment or community is more limited, but

nonetheless essential. One of the important aspects is to compare the impacts that are forecast with the effects actually observed during the life of the project.

4. Better methods of involving northerners in planning for projects that affect their way of life and livelihood need to be given much more serious attention by developers.

Comments: Public participation on an informed basis is the goal of all such activities. Involving the people concerned in the planning stages, rather than having them react after the fact is much to be preferred. This includes making southerners aware of northern facts (and vice versa), better planning at the government level where many problems of northerners are concentrated, and informed open discussion (if it is possible).

J.M. Harrison

J.E. Lillycrop

September 23, 1982

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INTERNATIONAL SYMPOSIUM
ON THE
DYNAMICS OF BOREAL FOREST ECOSYSTEMS:
FUTURE RESEARCH AND MANAGEMENT REQUIREMENTS

AUGUST 23 - 26, 1982

LAKEHEAD UNIVERSITY

ABSTRACTS OF PAPERS

130 ALBERT, OTTAWA, CANADA K1P 5G4 TEL: (613) 238-3525

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Author (s) Martin E. Alexander

Address Northern Forest Research Centre, Canadian Forestry Service, 5320 - 122 Street, Edmonton, Alberta, Canada T6H 3S5

NATURAL REGENERATION AFTER WILDFIRE IN THE BOREAL FOREST OF NORTHWESTERN ONTARIO

Permanent regeneration sample plots have been periodically installed and assessed on selected wildfire sites in northwestern Ontario since 1976 by fire research staff of the Canadian Forestry Service. To date, twenty-eight stands in upland jack pine (Pinus banksiana)/black spruce (Picea mariana) and lowland black spruce communities have been sampled on six wildfires that occurred in 1976 (2 fires), 1977, 1979, and 1980 (2 fires). Fire behavior in any one stand has varied from a low-intensity surface fire to an active crown fire. This paper summarizes six years of tree seedling and height data, and the associated structure and composition, site characteristics, fire history, seedbed condition, post-burn organic depth, and post-burn climatic conditions of each stand.

Author (s) Richard J. Barney

Address U.S.D.A., Forest Service, Intermountain Forest and Range Expt. Station, Northern Forest Fire Laboratory, Drawer G., Missoula, Montana 59806, U.S.A.

FIRELINE PRODUCTIVITY IN BOREAL ECOSYSTEMS: CONCEPTUAL, PRACTICAL, AND POLITICAL LIMITATIONS AND CONSEQUENCES

Fireline production is discussed first in a conceptual context with special reference to boreal ecosystems. The conceptual model provides a common basis to join and apply other physical and biological models to the building of fireline and related decision processes. Selected available boreal fireline production information is discussed in terms of the model. Current and future management problems related to political limitations and consequences are covered. This paper attempts to pull together the diverse information and philosophies regarding fireline production to provide a more responsive and problem-oriented data base, procedure, and synthesis of information. The author illustrates how fireline production information, including rate, consequence, and economic relationship, are key items in the planning, allocation, and management processes in the boreal ecosystems.

Author(s) R.A. Battson and K.B. Cawker

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THE METHODOLOGY INVOLVED IN THE DETERMINATION OF LONG TERM FIRE HISTORIES: AN EXAMINATION OF CHARCOAL AND POLLEN FROM MASHAGAMA LAKE, ONTARIO

This study involved an evaluation of the various measures of fire occurrence as recorded in lake sediments. A short core (90 cm.) was extracted from Mashagama Lake, northern Ontario. The basin was burned in 1948 and 1967. Charcoal percent and charcoal concentration (based on the total number of fragments) and charcoal area (modified from Waddington, 1969 were evaluated based on evidence supplied by loss on ignition, Pediastrum and the pollen spectra, which all exhibited clear responses to the recent fires in the watershed. In addition, comparisons of charcoal size class data between samples representing deposition from a burned environment versus samples derived from an unburned environment were made with the hope that some understanding of the mode of deposition could be attained.

Charcoal percent best represented the burned zone while charcoal concentration and charcoal area were found not to represent the two zones as expected. Charcoal percent was also significantly correlated with loss on ignition (r= -.680) and the sprouter-conifer ratio (r=.734), while charcoal concentration and charcoal area were not.

Examination of the size class data clearly indicated that the burned zone was dominated by smaller fragments (100-199 sq. μ) with fewer large fragments (2000 + sq. μ). Unburned zones had significantly fewer small fragments and proportionately more larger fragments. This indicated that the background charcoal must have been waterborne and that the increase of charcoal in the burned zone was due to increased airborne deposition. This has serious implications for the use of charcoal area as an indicator of fire in lake sediments. The large fragments contribute a great deal toward the total charcoal area of the sample. This problem is compounded since non-burned samples produce a greater proportion of large fragments. There is a need to repeat this study in other environments to substantiate the trend which is clearly evident in this research.

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Fallout and Natural Radioactivity in Canadian Northern Environment

Almost twenty years after the moratorium on atmospheric nuclear weapons testing (1963) a persistent radioactive burden of cesium-137 and other fission products can be detected on vegetation, in peat and soils in the boreal and arctic zone in Canada. This paper will review the present status of our knowledge of this burden based on the literature, a study of Cs-137 conducted by the authors along the latitudinal gradient from Riding Mountain National Park (50°N) to Alert, Ellesmere Is. (82°N), and on their recent survey of natural radiation due to uranium mineralization outcroppings in Keewatin District, N.W.T.

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EFFECT OF THE CHURCHILL RIVER DIVERSION ON WATERFOWL USE OF THE LOWER CHURCHILL RIVER, MANITOBA

Abstract

The effect of reduced flows resulting from Manitoba Hydro's Churchill River diversion project on waterfowl use of the lower Churchill River was investigated in 1978 and 1979. Changes in river morphology were documented with aerial photography in 1978 and 1981. Densities of waterfowl using areas on and away from the river in 1978 and 1979 are compared to pre-diversion waterfowl densities in the study area and to regional population trends. Altered flow regimes appear to have indirectly resulted in reduced use of the Churchill River by breeding ducks and geese. Low nesting effort by Canada geese was apparent on the river in 1979. It is suggested that this may be attributed to reduction in availability of attractive goose breeding habitat. Studies conducted in 1982 to determine trends in the Churchill River goose poulation and important habitat distribution are described.

Author(s) G.M. Courtin, G.I. James, S.V. Sahi, P.D. Thibodeau, and L. Wallenius

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DYNAMICS OF THE BIRCH TRANSITION COMMUNITY IN THE INDUSTRIALLY DISTURBED ECOSYSTEM, SUDBURY, ONTARIO

It has been suggested by Amiro and Courtin (1981) that the Birch Transition community is in a state of arrested development. Annual growth is offset by periodic crown die-back, and high soil surface temperatures in summer and frost heaving in early and late winter practically eliminate the establishment of seedlings.

Crown die-back cannot be attributed to a single factor but microenvironment, drought, and nutrient disorders resulting from acid, metal-contaminated soils all may be involved. Discoloured leaves that become evident in mid June have elevated toxic metal levels but no higher than those of adjacent green leaves. Leaf wilt and very low stomatal conductances that indicate stomatal closure have been observed on some shoots but not others on the same tree. Shoot water potentials less than -16 bar, measured in late July are attributed to physiological rather than physical drought since soil water potentials were never less than -5 bar.

Author(s) Claude E. Delisle

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LES MÉTAUX LOURDS DANS LES PRÉCIPITATIONS À OPINACA, BAIE JAMES
HEAVY METALS IN PRECIPITATIONS FROM OPINACA, JAMES BAY

Une étude réalisée au cours de l'été 1979 sur la qualité chimique de 31 épisodes pluviaux à Opinaca nous révèlent les concentrations suivantes (ug/l): plomb (7-450); cadmium (0,5-1,67); zinc (37-991); mercure (2-23); cuivre (8-165); nickel (0,1-40); aluminium (17-102); fer (21-77). Selon les évènements pluviaux, il ne fait aucun doute que d'importantes quantités de métaux lourds sont déposées sur les écosystèmes terrestres et aquatiques de la région de la Baie James augmentant ainsi les concentrations au-delà du bruit de fond naturel de ces métaux. Les effets écologiques, connus et inconnus qui s'en suivent, en sont d'autant plus importants. Les concentrations rapportées s'accompagnent toujours par des pH acides variant de 3,2 à 5,2 (moyenne de 4,7), ce qui favorise la lixiviation et l'ionisation de plusieurs métaux.

Dans un second volet, j'aimerais aussi porter à votre attention une expérience in situ que nous effectuons sur les effets de l'acidification sur le phytoplancton et le zooplancton du lac Kempt, Québec. Les résultats de cette expérience, menée sur huit enclos cylindriques en polyvinyle (2m x 2m) et d'un volume de 6 000 l ouvert à l'atmosphère et aux sédiments et acidifiés à différents pH, seront connus d'ici la fin de l'été 1982.

The following range of concentrations (ug/l) were found from a study of 31 rain events from Opinaca area, James Bay, during summer 1979: lead (7-450); cadmium (0,5-1,67); zinc (37-991); mercury (2-23); copper (9-165); nickel (0,1-40); aluminium (17-102); iron (21-77). Depending on rain events, it is obvious that important quantities of heavy metals are deposited on the terrestrial and aquatic ecosystems of James Bay. This phenomenon together with the rain pH which varied from 3,2 to 5,2 (average of 4,7) increased the concentrations above the natural background noise of these metals as well as the known and unknown related ecological effects. This acid rain promotes leaching and dissolution of many metals.

As a second topic I would like to draw to your attention an in situ bioassay conducted on the effects of acidification on phyto and zooplankton at Kempt Lake, Quebec. This experiment was conducted in eight polyvinyl cylindrical enclosures (2m x 2m; 6 000 l), set at different pH and open to atmosphere and sediments. Results are still under study and will be known by September 1982.

Author(s) C.T. Dyrness, R. Norum, C.W. Slaughter, V. Van Ballenberghe, L.A. Viereck, R.A. Werner, J. Zasada

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FOREST MANAGEMENT IN THE TAIGA OF ALASKA - ISSUES FOR INTEGRATED RESEARCH

High-latitude forests and associated renewable resources are being subjected to increasing pressures for extraction, "development" and overt management in Alaska and Canada. We outline several integrated research programs underway in the discontinuous-permafrost taiga of central Alaska.

1) Willow Island studies - The river bottom-land forests of central Alaska are highly productive of wood fiber, and comprise an important wildlife habitat and aesthetic (tourism) resource. The research plan focusses on the consequences of cutting and site preparation approaches for regeneration rates, site productivity, and floodplain succession processes and strategies.

2) Headwaters catchment management - The role of taiga uplands in providing freshwater resources, aquatic habitat and forest products is under study in a 104-km^2 research watershed. The scope provides for analysis of the influences of selected resource management practices (timber harvest, prescribed fire, accelerated biomass proudction) on the catchment/stream system.

3) Wildfire - A study of the way upland forests respond to fire was begun at the Washington Creek Fire Study Area in 1978.

4) Foraging ecology of moose in Denali National Park - Relationships between forage quality and population dynamics of moose in a subarctic ecosystem is the main focus of this study.

5) Management of white spruce stands to prevent losses of fibre production caused by bark beetles. The development of silvicultural treatments that promote vigorous tree growth on selected sites is the ultimate objective of this work.

These examples of current Forest Service integrated research are indicative of the breadth of questions and problems confronting resource managers in the north. Environmental issues which must be faced in the taiga are not susceptible to simplistic, single-discipline attack; developing the understanding which is requisite to rational planning, management and development demands continuance and intensification of multi-discipline, integrated long-term research in northern ecosystems.

Author (s) Robert E. Farmer, Peggy Knowles and William H. Parker

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Genetic Resources of the North American Boreal Forest

The North American boreal forest contains a relatively small number of dominant, widely distributed species each of which is adapted to a broad range of environmental conditions. These species' abilities for rapid migration account for their survival during periods of warming and cooling during the glacial cycles of the past 2 million years. Their genetic systems, which include wind pollination and mechanisms promoting outcrossing, have resulted in maintainence of high levels of genetic variability. This variability is expressed both within and between populations. Much of the variation between populations is expressed along environmental gradients as clinal or ecotypic differentiation, while some appears to be presently non-adaptive, perhaps reflecting adaptations acquired in glacial or preglacial times. Although little is yet known of variation in boreal shrubs and herbs, their patterns of variation appear less generalized than those of trees due to greater diversity in their genetic systems.

High levels of genetic variability in boreal tree species have significant implications for the management of boreal forest lands. Current efforts in regeneration have recognized the need to generally match seed source with planting area, and efforts are underway to genetically improve growth potential and other economically important characteristics by selection and breeding. However, a thorough assessment of the genetic resource has not usually been made in conjunction with management and breeding, though these activities may be presently altering the nature of the resource. To ensure conservation of the genetic resources of the boreal forest, tree improvement programs require broadening to better delineate patterns of natural variation and to better describe genetic systems. Management-impacted species such as aspen and balsam fir, which are presently receiving minimal research attention because of their current low economic value, are of special concern.

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EVALUATING THE ENVIRONMENTAL IMPACT OF HYDROELECTRIC DEVELOPMENT IN NORTHERN ONTARIO

Major energy resource developments may be expected to occur in northern Ontario over the next decades. McMaster University is establishing a multidisciplinary Research Program for Technology Assessment in Subarctic Ontario (TASO) to undertake long-term research in anticipation of the social, economic and environmental impact of these developments. This paper constitutes a preliminary report on economic investigations related to the present plans of Ontario Hydro to develop 16 sites at the Mattagami, Moose and Little Jackfish rivers. In it we briefly describe the nature of the TASO research program, the proposed developments and their probable environmental consequences. We then discuss the application of conventional project evaluation techniques to the valuation of these consequences and provide preliminary estimates of the order of magnitude of environmental costs and their distribution among native northern residents, non-native northern residents and others.

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The Bioclimatical Regions: A necessary framework for the study (comprehension) of the dynamics of boreal forest ecosystems

According to the present and expected exploitation of the northern Canadian territories, the comprehensive and global studies of their ecology is far from being sufficient, in quantity at least. This is also true for Québec. However, during the last decade, some efforts have been made to set up reconnaissance land inventories of the boreal and sub-arctic zones of Québec.

The highest level of perception used in Québec studies is the land regions, defined as large territories under the influence of an homogeneous macro-climate as expressed by vegetation and soils in their different characteristics.

This paper intends to present the methodological approach to land region classification, the results of the studies over 600 000 km^2 of the Québec territory and some interpretations of these regions in the field of forest composition and productivity.

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COMMUNITY PLANNING WITH THE NORTHERN RESIDENT

The majority of communities located in the boreal forest region are associated with resource extraction. Such northern resource communities differ demographically and socially from communities in the south, and the needs of residents vary accordingly. High rates of labor turnover characterise many of the communities creating serious economic and social problems. One partial solution to this problem is to design communities which produce higher levels of residential satisfaction. To achieve this goal the attitudes and preferences of residents must be incorporated into the planning process. A case study of two northern Manitoba communities, Thompson and Leaf Rapids, is presented to illustrate the methodological procedures for eliciting residents' attitudes. Results of the study are examined and the design implications are discussed.

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NUTRIENT CYCLING DYNAMICS IN DIFFERING SPRUCE AND MIXEDWOOD ECOSYSTEMS IN ONTARIO AND THE EFFECTS OF NUTRIENT REMOVALS THROUGH HARVESTING

Spruce forests are among the most important ecologically, geographically and economically in the whole North American boreal forest. Nutrient cycling dynamics and productivity of fully-stocked black spruce on two principal landtypes, peat and moist outwash sand, are elucidated and compared with those of two boreal mixedwood ecosystems consisting of white spruce, balsam fir, white birch and trembling aspen of moderate and high productivity. Comparisons are also indicated with those of north temperate red spruce ecosystems.

Mass budgets are described in which it is shown that overstory biomass/belowground reserve ratios are less than 10 for black spruce growing on outwash sand, while those for boreal mixedwoods are invariably over 20. Ratios for black spruce growing on peat are usually <1. Nutrient budgets are also described. From these budgets the immediate effects of full-tree harvesting on the nutrient pools of these sites are shown.

While simple budgets do not predict replacement times, data from nutrient cycles will. Nutrient residence and replacement times are shown for these ecosystems. Differences in residence times for nitrogen in red and black spruce ecosystems demonstrate the importance of fire in accelerating rates in the latter. Replacement times provide estimates of the real tolerances of these ecosystems to perturbations such as harvesting. It is shown that boreal upland mixedwood sites have much greater resilience than that of black spruce stands on outwash or peat. How and what we harvest will have substantial effects on subsequent rotation ages.

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SEASONAL PATTERNS OF NITROGEN MINERALIZATION FOLLOWING HARVESTING IN THE WHITE SPRUCE (PICEA GLAUCA (MOENCH.) VOSS) FORESTS OF INTERIOR ALASKA

The effects of commercial timber harvesting upon nitrogen transformations were evaluated for organic and mineral soils of mature white spruce (Picea glauca (Moench.) Voss) forests in interior Alaska. Analyses of organic soils incubated in situ in mature forest and two recently harvested areas of different ages, indicated an ammonium-dominated soil system for the unharvested area. Maximum NH_4-N mineralization rates (300 µg N/100 g dry soil/day) were found in mid-summer and generally declined with the onset of fall. In the harvested areas, rates of NH_4-N release were almost invariably lower in the uncut areas. Shortly after harvesting, NO_3-N levels were extremely high. Thereafter, they declined to levels slightly higher than in the mature forest. Nitrification was strongly enhanced by harvesting, and regular patterns within season were evident. For the youngest clearcut, the combined processes of ammonification and nitrification only occasionally supplied more nitrogen to the site on a daily basis than was supplied to the mature forest. Conversely, for the oldest clearcut, the supply from the combined mechanisms was variable and depended upon time since clearcutting.

GROUND FLORA DYNAMICS AND COMMUNITY STRUCTURE IN PLANTATIONS OF BLACK SPRUCE (PICEA MARIANA (Mill.) B.S.P.) AND JACK PINE (PINUS BANKSIANA LAMB.) PLANTATIONS NEAR LAKE NIPIGON, ONTARIO

The distribution and pattern of ground flora was investigated in young planted or seeded stands of black spruce (Picea mariana (Mill.) B.S.P.) and jack pine (Pinus banksiana Lamb.) near Lake Nipigon, Ontario. Stand age varied from 10 to 50 years. Cover-abundance and sociability indices were established for 119 species of vascular flora, lichens, mosses, shrubs and tree seedlings on 205 random plots. Species-area relationships indicated a richer floristic composition under black spruce, indicating a more impoverished site regime for jack pine. The data were further subjected to cluster analysis and 4 types of ordination: principal components, polar, weighted averages, and reciprocal averaging. Principal components gave the best results. When uncommon plants were eliminated from the data, 60-65% of the variation in ground flora could be explained by 3 factors. These are hypothesized to be light (canopy density), moisture (soil texture) and fertility (site quality).

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Areal Variations in Species and Timber Assortment Composition of the Finnish Forests

There are only three main tree species in the Finnish forests, pine, spruce, and birch. As a result of the great extent of the country from south to north, from 60° to 70° N latitude, considerable areal differences are found between different parts of Finland in volume of growing stock, species and timber assortment composition, increment per unit area etc. An east-west axis of variation is also noted, in that the forests of the western part of the country are in a less advantageous position in respect of certain growing stock properties than those of Central and Eastern Finland. This is chiefly due to the predominantly flat terrain and the resulting high incidence of paludification, and also in part to historical factors connected with forest utilization and its consequences. Areal typologies are made based on the results of the 6th National Forest Inventory and the structures of the "taxable cubic metre" by communes.

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Fire History and Ecology of Forest Ecosystems in Kluane National Park - Fire Management Implications

An investigation was undertaken in Kluane National Park (KNP), Yukon to aid in the development of a fire management plan for the Park. A study of the fire history and ecology of forest ecosystems (classified by Rowe (1972) as the Kluane Section (B.26d) of the Boreal Region) in KNP was undertaken to determine the ecological role of fire in vegetation renewal and succession.

Results of the study indicated that lightning is very infrequent as an ignition source in KNP. Man-caused fires were important in vegetation renewal, especially since the late 1800's as indicated by difference in fire frequency between remote and heavy human-use study areas within the Park. The vegetation mosaic now evident on the landscape which supports a wide variety of wildlife is partially dependent on man-caused fires (early Europeans and native Indians). In addition to fire, glacial movement exposing new material and also causing lake formation and drainage have resulted in vegetation renewal and initiated succession.

The fire management strategies developed by Parks Canada for KNP should consider these vegetation cycling mechanisms. Decisions will be made as to what vegetation mosaic will be perpetuated considered by Parks Canada as "the natural resources within the Park (Parks Canada Policy (1979))". If only lightning fires are considered for re-cycling vegetation, the average age of forest stands will increase, species changes will take place (i.e. trembling aspen to white spruce), and vegetation mosaics will change resulting in less landscape vegetation diversity.

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EFFECTS OF THE MINING AND SMELTING INDUSTRY ON BOREAL FOREST SYSTEMS: PAST, PRESENT AND FUTURE

The mining and smelting industry in Canada has had a significant effect on boreal forest systems. In the early 20th century impacts were acute resulting from ground level emissions of SO_2, which brought about widespread vegetation damage, and initiated the exclusion of sensitive species and eventually soil erosion. The most familiar example of this type of damage is Sudbury, Ontario. The elimination of ground level roasting of ore brought about some improvements in the local situation but impacts due to the emissions from low stacks still occurred. Since the 1960's many smelters have been improved, taller stacks have been built and emissions have been reduced. These changes have resulted in local improvements in several centres and can be attributed to reductions in ground level concentrations of SO_2. New smelters using taller stacks have not shown the same severity of local effects seen adjacent to older smelters, but effects on sensitive species are still present. The changes in SO_2 concentrations at ground level have led to decreased emphasis on the SO_2 effect and an increased awareness of the effects of metal particulates and acid deposition. The past, present and future impacts of smelter emissions from several sources will be discussed in light of their deposition pattern, accumulation and long term effects.

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A SOCIOLOGICAL EXAMINATION OF ENVIRONMENTAL HEALTH CONCERNS IN SELECTED REMOTE NORTHERN MANITOBA COMMUNITIES

The identification and recognition of unsafe drinking water supplies in remote northern Manitoba communities has been acknowledged for a period of time in excess of twenty years. One of the significant features of the environmental health concerns, which arise from contaminated community water supplies, has been the persistence of this problem to defy remedy. Five communities are included in this study. They are, Norway House, Nelson House, Cross Lake, York Landing and Split Lake.

Incidents of water-borne illnesses in remote northern Manitoba communities have been recognized as being significantly higher than the overall provincial rates. Dependence on surface water, the only available water source, has left communities vulnerable to disruptions in the quality of surface water. Frequent waste water treatment plant breakdowns, spillage of petroleum products and either inadequate or non-existent solid waste management practices were found to be contributing factors to the contamination of lakes and rivers.

Under the present circumstances, there are no available means for co-operative planning among the various government agencies, who have an interest in environmental health conditions. Government agencies often complicate the water problem by attempting solutions to the environmental health/water quality dilemma in isolation of the total available expertise and resources, e.g. community planning in isolation of effective input of either health or environmental specialists.

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CHANGES IN TREE SPECIES COMPOSITION IN NATURALLY REGENERATING BOREAL FOREST CUTOVERS

A long-term study of regeneration in alternate strip clearcuts in shallow-soil upland black spruce near Nipigon, Ontario, has revealed shifts in tree species composition. The original forest, dominated by black spruce and having only minor tree size components of jack pine, balsam fir, trembling aspen and white birch, has changed to a black spruce-white birch-trembling aspen mix in the regenerating strips. Several factors influenced variations in the exact proportions and quantities of the hardwood and conifer species--scarification versus non-scarification, topographic position (related primarily to moisture regime), leave time of the residual strips, and proximity of mother tress in the original forest (as a source of seed and/or root suckering). A number of other studies, or unpublished data sets, indicate that species compositional changes are common place in boreal cutovers. The implications of these findings to refining the strip cutting system, and to the impacts of other harvesting systems on the composition of future forests, is discussed.

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A CLASSIFICATION AND ORDINATION OF FOREST ECOSYSTEMS IN THE NORTHERN CLAY SECTION OF ONTARIO: A FRAMEWORK FOR FOREST MANAGEMENT

A classification integrating twenty-three vegetation types and fourteen soil types was developed using data collected from two hundred and fifty forest stands throughout the Northern Clay Section of Northeastern Ontario. Stands were first classified using TWINSPAN, a polythetic divisive classification technique, according to their vegetational attributes (species, % cover), and then according to various field recognizable soil attributes. Ordination using DECORANA, a detrended correspondence analyses technique, revealed vegetation types trending along complex environmental gradients related to moisture and nutrients. Soil types were related primarily to texture and moisture. A synthesis of vegetation and soil types resulted in the discrimination of fourteen "operational groups". These groups provide a satisfactory framework for future forest management activities as well as further research in the region.

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NATIVE CANADIAN INTERPRETERS MULTIPLE ROLE FUNCTIONS IN HEALTH CARE DELIVERY

Inuit, Dene, Cree, and Saulteaux interpreters in the Health Sciences Centre and St. Boniface Hospital (Winnipeg, Manitoba) are vital links in the delivery of heath care to Native patients. Not only do they "translate" for patients and health personnel, but they also act as culture-brokers, patient advocates, and health educators. This paper discusses the roles of interpreters and the problems they encounter.

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Parks Canada in the Boreal Forest Ecosystem

Parks Canada manages ten National Parks within Canada's Boreal Forest Ecosystem and is striving to expand this representation. The Parks, separated by considerable geographic distances, contain and protect a wide cross section of the Boreal Forest ecotypes. The management objectives within these reserves or "genetic libraries" differ but are nevertheless similar in that they are governed by a common Act, Policy, Management Guidelines, and finally, Resource Management Process.

Within the areas now being managed, actions being taken regarding the reintroduction of fire, exotic species management, data gathering and analysis and other specific issues are discussed in the paper. The opportunities for the science community and the potential contributions to the understanding of the Boreal Forest Ecosystem that these issues provide are also detailed.

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FIRE IMPACT MANAGEMENT IN THE BOREAL FOREST REGION OF CANADA

Increasing awareness that fire is a natural component of boreal forest ecosystems is fostering growing opposition to traditional fire exclusion policies. Fire managers can, at considerable cost, mobilize large amounts of resources in efforts to exclude fire. Since many people live and work in the boreal forest region of Canada, potential and actual threats to their social and economic well-being are resulting in increasing pressure to do so. The author advocates a policy of fire impact management whereby decisions concerning the suppression of wildfires and the use of prescribed fire are based on sound social, economic, and ecological principles, and discusses some of the practical problems associated with such a policy.

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Production of Edible Mushroom Mycelium in Peat Hydrolysates

Submerged culture production of edible fungi mycelium has potential as a food or feed supplement. Several substrates have been utilized in the growth of different mushroom species and studies have been conducted in assessing their nutritional properties.

This paper deals with the submerged growth of edible mushroom mycelium utilizing peat hydrolysates as substrates. Sphagnum peat acid extracts have been obtained and successfully utilized in fermentation processes for producing fungi mycelium. The effects of several operating variables on the process and biomass yields and concentrations obtained are presented.

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IMPACT OF ELEMENTAL SULPHUR DUST DEPOSITION ON SOILS AND VEGETATION OF LODGEPOLE PINE STANDS IN WEST-CENTRAL ALBERTA

A set of 26 sites were established in the vicinity of two sour gas processing plants in west-central Alberta to determine the present condition of Pinus contorta - Picea glauca stands and their soils. Sites close to sulphur dust sources at the gas plants demonstrated significantly reduced soil pH and associated chemical changes as well as distinct reduction in the cover of understory plant species. The large number of sulphur blocks in Alberta and elsewhere and the magnitude of ecological response makes this an important future research area.

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ECOLOGICAL EFFECTS OF HYDROELECTRIC DEVELOPMENT IN NORTHERN MANITOBA, CANADA: THE CHURCHILL-NELSON RIVER DIVERSION

The Churchill-Nelson hydroelectric development is a major energy-producing scheme with a total generating potential of 8400 MW. The majority of the flow of the Churchill River was diverted south into the Nelson River basin for power production on the lower Nelson. The flooding of Southern Indian Lake, on the Churchill River at the point of diversion, resulted in severe physical disruption due to extensive shoreline erosion of fine-grained glacial clays. Light penetration was greatly decreased in the main basins of the lake because of eroded clay in suspension. Minor changes occurred in primary production and in the species composition and standing crops of marcobenthic invertebrates and crustacean zooplankton. These changes were attributed to increased concentrations of suspended sediments, increased outputs of organic material and nutrients from flooded vegetation and soils, and changes in flushing rate and temperature resulting from Churchill River diversion. Major declines in the catch per unit effort of whitefish in the Southern Indian Lake commercial fishery occurred and the quality of the catch declined significantly. Mercury levels in fish increased in all lakes flooded by the Churchill River diversion, apparently due to the mobilization of naturally occurring mercury from flooded soils. Effects of manipulations in other parts of the system included drastic reductions in discharge of the lower Churchill River and area of lower Churchil River lakes; extensive flooding of the Rat River valley, with severe oxygen depletion in the new reservoir; and reduced year class strengths of coregonid fishes due to winter-spring drawdown in Cross Lake.

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The Subarctic Woodlands of Northern Quebec

A review is presented of research carried out at the McGill Subarctic Research Station (Schefferville) on the subarctic spruce-lichen woodland ecosystem, which is dominant on freely drained sites at the northern edge of the boreal forest. Topics covered include: eco-physiology, biomass and productivity, nutrient cycling, spruce-lichen interactions, the impact of fire and the impact of acidic precipitation. Suggestions are made as to further topics of research within this ecosystem.

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ABUNDANCE AND DIVERSITY OF SMALL MAMMALS IN MIXED AND PURE JACK PINE FORESTS

Intensive forest management in north-central Ontario will lead to greater use of planted monocultures. Mono-specific stands of jack pine are generally considered to be sterile wildlife habitats. To test the validity of this idea we compared the abundance and diversity of small mammals in mixed and pure jack pine forests near Gogama, Ontario. Small mammals were sampled in summer 1982 using a combination of snap traps and pitfall traps. The study areas included a recent burn, recent clearcut, young (10-25 years), medium (30-45 yrs.), and old (55-70 yrs.) forests. We describe variation in diversity and abundance within and between forest types and relate these observations to physiognomic attributes of the forest communities.

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CLIMATIC CHANGE AND THE BOREAL FOREST: A PERSPECTIVE FOR MANAGEMENT

The future status of the Canadian boreal forest may be substantially affected by the expected atmospheric warming due to carbon dioxide increases, with effects on tree regeneration, management policy, and economics. Currently, the "noise" in the atmospheric system is thought to be obscuring the climatic "signal" of increasing warmth, which is expected to become detectable during this decade, and to increase mean summer temperatures in sub-arctic and arctic areas by 4 - 5^0C.

Because there are uncertainties in estimating the biome response to this potential warming, we may use paleo-ecological studies of former natural climatic warmings to help estimate the forest's response to the expected anthropogenic warming. The causes of the past and future warmings may not be the same, but the similarity of temperature anomalies for the mid-Holocene and for the expected warming makes the past a useful analog. Hypsithermal movements of forest into tundra regions of Keewatin and Mackenzie Territories resulted from mean summer temperature increases of 3 - 5^0C. I suggest that the potential CO_2 warming of the next few centuries might achieve similar forest invasions of the arctic tundra, resulting in conversion of up to 500,000 sq. km of Canadian tundra to woodland, as was the case in the hypsithermal episode. The speed of this afforestation is likely to be quite rapid, and can be estimated from paleo-ecological studies.

The ecological history of the southern limit of the boreal forest is less well known than is the forest-tundra ecotone, but studies by Ritchie and myself show northward displacement of the prairie-woodland boundary during the mid-Holocene warm interval. This displacement was similar in direction and timing to the shifts of the forest-tundra ecotone, suggesting that an analogous CO_2 warming would result in the northward displacement of the entire boreal forest biome. Potential cereal-growing climates would penetrate the southern fringes of the boreal forest, as they did in hypsithermal times.

ENERGY PRODUCTION IN THE BOREAL FOREST ZONE

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The boreal forest zone effectively extends from Inuvik (NWT), to St. John's (Nfld) in a broad arc sometimes as much as 800 km in depth; it is of interest to energy planners and producers because it has the potential to supply energy in its many forms to the consumers both within Canada as well as in export markets. The major energy consumers in the zone are the energy industries themselves and the minerals extraction and refining industries. As a consequence the region has one of the highest energy consumption/capita indices in the world; however, there are also many 'remote' communities of native peoples who have extremely low per capita commercial energy consumption mainly as a consequence of the high cost of electrical energy supplies.

The 1980's ushered in a period of considerable uncertainty with respect to the Giga-Dollar energy projects in the zone. Not only projects based on fossil fuels such as gas, oil, oil sands and uranium, but also those based on renewable hydro electricity producton, have been cancelled or deferred in the light of current economic conditions.

The energy production potential of the oil sands was projected at 150,000 cubic metres/day of syncrude by the year 2000. This corresponds to almost 50% of the anticipated domestic crude requirement in that year. The role of the zone in making up the shortfall in traditional crude production is clear: the reason for the deferment of projects was primarily the high investment costs required; approximately half a million dollars is required for a production rate of a cubic metre per day. Similar large investments in the tens of billions are required for gas and oil pipelines and hydro-electric developments. Energy projects will be a major stimulus to the development of the boreal forest zone with oil, oil sands and gas predominating west of Hudsons Bay and hydro-electric projects mainly in Quebec and Labrador.

The prospect of renewable resources such as small scale Hydro, Wind, Solar and Bioenergy substituting for oil based electricity generation in remote communities is now very good as a result of the research, development and demonstration activities occasioned by the first world oil shock of 1973. With further development the renewable resources of the Boreal Forest zone could be used in an integrated development of a sustainable supply of energy and materials.

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HORSE PRODUCTION FOR NORTHERN AREAS

It is estimated that there are approximately 700 thousand horses in Canada. Almost without exception they will all be exported as human food. Canada exported 16 million Kg of horse meat in 1980 which grossed about 25 million dollars. This represented about 70,000 horses slaughtered, as was 5 times the amount reported for 1967.

The horse can utilize lower quality forage than the ruminant animal and so is able to survive and thrive in our northern areas where beef cattle would perish. The use of land in northern Canada for ranching beef cattle is limited by the length of the grazing season. In most areas it is necessary to provide up to 2-3 tons of hay per cow to bring it safely through the winter. Horses can paw through up to 50 cm of snow for their sustenance. They are therefore able to utilize much of the aftermath from seed fields as well as some of the sedge-grass mixtures from wet and inaccessible areas. A horse operation in northern B.C. running 450 head has shown that horses wintered easily even in the high snow of this past year. In most years only mares in foal and weanlings require supplemental feed for about 60 days from February on. Horses have a great flexibility in marketing, do not need grain for finishing but do need maturity and fat cover.

One of the greatest advantages of a large scale horse production operation is that it is energy efficient as well as labor efficient compared to cattle production. To date we do not have any research underway as to breeding or feeding of horses for the meat trade.

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PROBLEMS OF MULTIPLE USE FORESTRY IN THE NORTHERN BOREAL ZONE OF FINLAND

Due to geographical, social and institutional factors, many uses of forest land are found in Finnish Lappland. The major land use is timber growing and harvesting, but reindeer grazing is a traditional land use which still gives employment and income to rural peoples. Three-quarters of the total number of reindeer graze in the coniferous zone and conflicts between timber production and grazing are one of the most discussed topics. Hunting and fishing were occupations but now they are carried out for secondary income or as recreational activities. Collecting of forest and peatland berries and edible fungi is for family use although income is sometimes realized. Collection of cloud berries in some cases has suffered because of peatland drainage for timber production. Protection of forests is especially important near timber line areas. The Protection Forest Zone, including polar and alpine timber line areas, was established in 1939. The scale of cutting, as well as cutting methods, in this zone are questions which have long been discussed. During the 1930's, but more importantly during the 1970's, many new National Parks, Strict Nature Reserves and Wilderness Areas were established. The relative merit of increased employment and decreased wood supply are still debated. Tourism in these areas is regarded as one of the many and expanding industries in Finnish Lappland. Conflicts with timber supply is mainly local.

In general, there are many conflicting aims, even with nature conservation and outdoor recreation, and these provide a challenging field for forest managers.

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ECOLOGICAL LAND CLASSIFICATION AND EVALUATION IN SOUTHERN YUKON: AN AID IN IDENTIFYING RESEARCH AND MANAGEMENT REQUIREMENTS

A variety of ecosystems are described in the discontinuous permafrost zone of southern Yukon. Functional relationships between landforms, soils, vegetation, water bodies and faunal communities are stressed within the complex energy regimes resulting from the modification and redistribution of climate in mountainous landscapes. Sequential development of ecosystems under natural conditions and following disturbance are described and the management and research implications of manipulating ecosystems in northern environments discussed.

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ENERGY FROM FOREST BIOMASS FOR REMOTE COMMUNITIES

The potential for forest biomass as a feedstock for energy, in whatever form, has been discussed at length in relation to existing forest industries in Canada. To move beyond this physically, to the North, outside of the economic transport range of the forest industries, to northern communities beyond the electric grid, to small settlements with high cost energy but relatively low demand requires rethinking of the problems involved.

Wood has been a source of energy to mankind since pre-recorded history. It offers Canadians in the North a means to free themselves from the increasing costs of fossil fuels at the expense of some lack of convenience, but with a resulting increase in local employment and the retaining of energy costs within the community. New technologies in the harvesting transformation and final conversion of biomass make it increasingly attractive both physically and economically to remote communities.

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THE USE OF DOMESTIC PEAT AND WOOD RESOURCES IN ENERGY PRODUCTION IN NORTHERN FINLAND AND ITS INFLUENCE ON REGIONAL DEVELOPMENT

Since World War II until the middle of the 1970's, the heating energy produced by wood was replaced by imported fossil energy forms even in the rural areas of Northern Finland. The highest point of this trend was reached in the middle 1970's when international energy crises were turning development toward domestic and local energy resources. Now much energy for heating and electricity is produced by peat and wood chips power stations, as well in cities as centres of rural communes in Northern Finland.

The energy problems have rapidly created a need to study regional peat and wood resources, their availability, transportation systems, and regional impact on human activity and conservation. This paper is a short survey of a recent study in this field in the Department of Geography, University of Oulu, Finland. The research material is based on map 1:20000 analysis, statistics received by a detailed questionnaire sent to all communes and main energy production and consumption units in the research area in 1981.

The total amount of peat in Northern Finland is some 5 billion m^3, of which only approximately 3% is now utilized or planned to use. The annual harvest of energy wood could be as much as one million m^3 in the same area. Though the use is now starting, the total value of domestic energy production was equivalent to some 200,000 tons crude oil. The production employed some 1600 man labour years, and the value of the total salary for the local labour force was US $16 million in 1981.

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IMMEDIATE EFFECTS OF A FOREST WILDFIRE ON SOME INVERTEBRATES, SMALL MAMMALS AND BIRDS IN NORTHERN ONTARIO.

Animals were trapped or observed in burned and adjacent unburned forest during the first six weeks following a 900 acre wildfire in May. Comparison of burned and unburned areas distinguished between taxa whose abundance in response to the fire increased, decreased or did not change. Among nine invertebrate taxa sampled Gastropoda, Hemiptera and Lepidoptera decreased, while Diplopoda, Araneae, Orthoptera, Coleoptera, Diptera and Formicidae did not change. Responses of the 25 taxa within Coleoptera varied. Most marked responses were: Cicindela longilabris and Hylobius spp (increased); Calathus spp, Agonum retractum and Staphylinidae (decreased); and Pterostichus spp (did not change). Of the 10 mammal species sampled the least chipmunk Eutamias minimus increased; the masked shrew Sorex cinerus, eastern chipmunk Tamias striatus, redback vole Clethrionomys gapperi and snowshoe hare Lepus americanus decreased; while five species, most notably the deer mouse Peromyscus maniculatus, did not change. Of the 43 observed bird species 13, in particular the common nighthawk, yellow-shafted flicker, American robin and eastern bluebird, increased; nine species, in particular the ovenbird, common yellowthroat, various warblers and the ruffed grouse, decreased; while 21 species, in particular the white-throated sparrow, did not change. In general the results illustrate the influence of mobility and habitat requirements on response to abrupt environmental change, and suggest the boreal animal community, as sampled, possesses considerable stability.

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FOREST FIRE WEATHER AND WILDFIRE BEHAVIOUR IN THE BOREAL FOREST OF NORTHWESTERN ONTARIO

A combination of extreme forest fire weather and receptive forest fuel complexes has produced a number of severe wildlife problems in the boreal forest region of northwestern Ontario in recent years. This paper summarizes, in general, fire weather conditions and fire incidence in this region during the 1971-1980 period with particular emphasis on the 1980 fire season. Two significant 1980 wildfires, Kenora #23 and Thunder Bay #46 are analyzed in detail.

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Impact of intensive harvesting on the nutrient budgets of boreal forest stands.

The effect of intensive logging systems on future forest productivity was assessed on 4 contrasting stand conditions in the Nipigon area: a young coniferous (*Abies balsamea* (L). Mill.) stand, a young deciduous (*Populus tremuloides* Michx. - *Betula papyrifera* Marsh.) stand, and two 126 year-old *Picea mariana* (Mill.) BSP. stands, one established on deep mineral soils, the other on shallow soils restricted by bedrock. Parts of these stands were harvested by Domtar Forest Products using a whole-tree chipping process. The uncut portion of the stands were sampled to determine biomass and nutrient exports associated with intensive (whole-tree) logging and conventional (stem only) harvesting. Although biomass removal increased 56-116% with full tree utilization corresponding nutrient removals from these sites increased 83-224%. Higher nutrient losses reflected large differences in elemental concentrations between stems and foliage. Nutrient content of the stands varied with age and species.

Nutrient exports at harvest were compared with the existing nutrient reserves of the forest floor and mineral soil, and with the quantities of nutrients returned as logging residue. Assuming steady state nutrient cycling results indicated that nutrient losses from conventional harvesting were relatively modest with regard to soil nutrient supplies. However, on 3 out of the 4 sites studied intensive logging methods would lead to deficiencies in P,K or Ca in the succeeding rotation. Forests on deeper soils,managed at long rotations were less susceptible to nutrient deplention than short rotation stands established on shallow soils.Silvicultural strategies minimizing potential nutrient loss from intensified harvesting are discussed.

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DYNAMICS OF A BLACK SPRUCE ECOSYSTEM IN COMPARISON TO OTHER FOREST TYPES: A MULTI-DISCIPLINARY STUDY IN INTERIOR ALASKA

For the past several years the University of Alaska and the Institute of Northern Forestry have conducted a multi-disciplinary study of a black spruce ecosystem in interior Alaska. The black spruce type, widespread in interior Alaska, is the most fire-prone forest type. Black spruce ecosystems are also the most nutrient limited and least productive forest type, especially in late stages of succession.

The central hypothesis of this study is that ecosystem differences in productivity and degree of nutrient limitation are controlled mainly by soil and forest floor temperatures. A corollary hypothesis is that in the black spruce ecosystem, which is characterized by low productivity and slow nutrient cycling, fire acts as a rapid decomposer and is essential to replenish available nutrient pools.

In order to test these and other hypotheses a number of semi-intensive sites were studied for comparison with the black spruce permafrost-dominated intensive site. These semi-intensive sites represent a complete spectrum from the coldest sites to the warmest and driest sites that support tree growth in interior Alaska. The sites were also selected to represent both successional and mature stands.

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AN INVESTIGATION INTO SELF THINNING AND GROWTH OF NATURAL BLACK SPRUCE STANDS IN THE CLAY BELT OF NORTHERN ONTARIO

Even-aged black spruce (Picea mariana (Mill.)BSP.) stands in the Clay Belt of northern Ontario were sampled in order to investigate the -3/2 self-thinning power law. This phase of stand growth is characterized by a period of substantial density-dependent mortality due to intra-specific competition, the relationship between density and mean tree volume on a logarithmic scale having a slope of -1.5. Plots were established in five age classes, covering a span of 40-80 years, with a density range of 2000 to 10,000 trees per hectare. Six trees per plot were felled and sectioned for stem analysis. All stems (living and dead) were aged from basal cores or discs. On-going analyses will reveal the nature of the volume-density relationship in natural stands of black spruce. The forester could utilize such a relationship in stand density management of this economically important species.

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BOREAL FOREST PRODUCTIVITY (FIBRE)

Boreal forest productivity for conventional fibre products (pulpwood and sawlogs) is defined and compared with temperate forests. Distinctions are made between productivity of virgin forest stands (usually of fire origin); productivity of cutover stands and the allowable cut of whole forests in sustained yield units.

The potential of conventional silvicultural practices to improve boreal stand level productivity are examined in terms of the technical effects of yield functions. Yields of intensively managed boreal forests in Scandinavia are examined. Constraints of more intensive management of boreal forests, such as tenure arrangements with corporate licencees, funding of Crown forest administration, isolation, failure of plantations, lack of hardwood markets, social problems and provincial policies on Crown stumpage prices are briefly reviewed.

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PROVINCIAL MINISTRIES OF NORTHERN AFFAIRS: A COMPARATIVE ANALYSIS

The paper will present a comparative analysis of the northern ministries of Ontario, Manitoba and Saskatchewan as well as of the Secretariat des Activités Gouvernementales en Milieu Amerindien et Inuit (S.A.G.M.A.I.) in Quebec. The paper begins with an analysis of the reasons for the formation of the ministries. This is followed by a description of the nature of the regions and populations served by each of these agencies. Then a comparison will be made of the policy objectives and consequent range of responsibilities of the agencies. This involves, among other things, a comparison of staffing in terms of size, background and location. The next section of the paper deals with the relations of the northern agencies with both vertical and horizontal ministries within each province and with the relevant federal agencies. This will be followed by an analysis of the relations of the agencies with regional pressure groups. The paper will conclude with a look at the policy outputs and problems faced by these relatively new structures and make some suggestions as to what the future might hold.

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MECHANISMS OF INSECT POPULATION RESPONSE TO BOREAL FOREST MONOCULTURES

Probabilities of pest outbreak are frequently assumed to increase as monocultural forestry practices become more pervasive. Our investigations of insects colonising northern Ontario jack pine (Pinus banksiana) dominated forests focus on mechanisms of population response to varying stand "architecture". Specifically tested are P. banksiana density, foliage background diversity (of both canopy and understory vegetation) and age-class uniformity effects on host tree colonisation by foliage and wood exploiting insects. According to this perspective, increased rates of immigration, diffusion, persistence, oviposition success and resulting population density change are considered biological responses to host tree dispersion within a site. The degree to which monoculture conditions may cause lowered persistences of predators, parasites and parasitoids while facilitating the spreading of harmful insects is also addressed.

Recommendations for ecologically-based management practices are preceded by proposals for experimentally evaluating inter-planting as a viable technique to lower outbreak susceptibility.

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FOREST FIRE ELIMINATION AND ITS CONSEQUENCES FOR THE FLORA AND VEGETATION OF THE BOREAL FOREST

The importance of fire perturbations for the structure and function of the preindustrial forest landscape have been quantified by the dendro-ecological methods, in conjunction with old land survey records. In the boreal forest of northern Sweden, fire previously created an extensive forest vegetation mosaic in different successional stages. A general fire return interval of about one hundred years can be calculated for the whole forest landscape. Within this general fire rotation there were, however, great variations. Many sites burned up to five times each hundred years while others have been undisturbed by fire or other factors for hundreds of years. This mosaic of frequently disturbed and undisturbed sites was mostly created by physiographic features of the landscape in unpopulated areas.

Today the natural fire influences have more or less been eliminated and the vegetational mosaic has consequently changed. Many rare species adapted to early successional stages have decreased as a consequence of this. The types of disturbances created today by modern forestry practice are not suitable to many of these plants. Especially in the north, with long logging rotations, the forest is disturbed too seldom and in a way unsuitable to the survival strategy of many species. The organisms adapted to naturally undisturbed sites of fire-refuge character with long-term continuity in succession on the other hand are threatened today by modern logging operations because the sites are disturbed too often.

Because of the total change in disturbance regime of the boreal forest during the last century we have today the problem that forest sites are disturbed both too often and too infrequently and, perhaps more importantly, in a manner unsuitable to the survival and establish-strategy of many organisms.

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ABSTRACTS OF PAPERS

ADDENDA

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CONSTRAINTS RESULTING FROM THE DYNAMICS OF BOREAL FOREST ECOSYSTEMS - A RESOURCE MANAGER'S VIEWPOINT-

Forest management consists of using four basic kinds of tools, scheduling of harvest, distribution of harvest, silvicultural renewal and protection, to regulate forest dynamics towards maintenance of sustainable use levels of the forest. These four actions are closely related, and the planned use of each requires forecasting the biological dynamics that will ensue implementation. A major constraint to management is the absence of comprehensive theories of biological dynamics to lend a more solid scientific base to the decision forecasting.

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THE REGENERATION OF JACK PINE AND BLACK SPRUCE FROM SEED ON BURNED ORGANIC MATTER IN THE BOREAL FOREST

When fire burns through many forest ecosystems in boreal regions, considerable depths of organic matter may remain on the soil surface. This represents a harsh microenvironment for tree seedling establishment. This paper discusses the limitations to successful seedling establishment caused by high soil temperatures and soil moisture levels in the surface layer of the organic matter. From experimental data and published literature it is suggested that jack pine shows greater establishment success than black spruce on sites that dry at a faster rate and on soils with a higher temperature.

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MINERAL RESOURCES IN THE BOREAL FOREST

If Canada is to retain its share of world metal markets and maintain an important sector of its economy, new mineral deposits must be discovered in order to replace depleting resources. Approximately 200 new mines must be discovered by the year 2000 simply to maintain our current industry. Although we have maintained a relatively constant supply of new metals, physical limitations on existing technology require that new, innovative methods of exploration, coupled with a push into more remote, drift covered areas will be required in the next 20 years. In order to assist exploration, as well as enable the orderly planning and development of remote areas, geologial guidelines for resource potential studies are in increasing demand.

The guidelines are obtained from the study of mineral deposits and their geological settings. This research involves the classification of deposits, intensive investigation of specific examples of each deposit type, and more broadly-based examination of the relationship of all deposit types to the principal regional geological characteristics. The critical geological elements which are directly related to the ore forming process become the primary positive identifiers of resource potential. These elements must be carefully studied to determine their characteristics and relative importance. Once a good set of geological criteria are established, they can be used in conjunction with geological maps to establish the resource potential of large regions of Canada. Obviously, these guides must be sufficiently large to be obvious on regional (1:50,000) maps, and thus generally are not sufficiently precise to enable direct discovery. Advanced remote sensing technology, coupled with more precise geological guides, will enable discovery rates to be maintained. The principal deposit types are volcanic-hosted massive sulphide deposits (Cu, Zn, Ag, Au), magmatic nickel deposits (Cu, Ni, Pt), gold deposits, uranium deposits, and iron deposits. All except uranium occur in volcanic and sedimentary domains (greenstone belts); many poorly exposed and poorly mapped domains of this type occur in the remote regions of the Shield, and will likely yield important new discoveries. Uranium deposits are confined primarily to areas of sedimentary cover rock. The Athabaska, Thelon and Nipigon Plate districts all have good resource potential; important new discoveries have been made in the former two areas.

As discoveries are made in the remote districts, new transportation technology, coupled with innovative work scheduling to reduce the requirement for new townsite development, may be required. Tailings disposal must be well-designed and carefully monitored, in order to protect the fragile subarctic ecosystem. Technological requirements including environmental protection measures, require some new research. Mining in these regions will be a reality within a decade or two.

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GEOLOGY AND ACID RAIN, EASTERN BORAL FOREST

Much of the boreal forest of Eastern Canada is growing on soils developed on unconsolidated deposits derived by glacial erosion of the rocks of the Canadian Shield. The generally siliceous and coarsely crystalline texture of Shield rocks has produced glacial deposits that are relatively thin, sandy, and stoney except in regions flooded by postglacial seas or proglacial lakes, where thick clayey deposits may be present. Outside of the areas where glaciers dispersed carbonate minerals from the limestones and dolomites of the Hudson Bay basin, the St. Lawrence Lowlands, and the Lac St. Jean basin, drift on the Shield tends to be non-calcareous and impoverished in clay-sized detritus. Thus, relative to other geologic terranes, drift covering the eastern Canadian Shield bears few components that can consume the excess protons delivered by acid rain without releasing other cations that may have adverse effects on the ecology of the eastern boreal forest. The mineralogical composition of the drift is complex, reflecting the complex geology of the region, and many mineral phases contain potentially toxic minor and trace elements that may be mobilized by ion exchange processes or as their lattices are altered by reaction with the excess flux of protons. Although the potential for damage to the timber resources and the terrestrial and aquatic food chain is as yet unknown, it is important to develop an inventory of data on natural regional variations of metal concentrations and of neutralizing components. Maps of these variations can serve as a background for estimating where areas of greatest potential alteration of the ecological system are located. A demonstration project that provides such maps has been carried out on the most southeasterly extension of the Canadian Shield in Ontario, near the edge of the boreal forest.

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DENSITY OF SPRUCE GROUSE IN BOREAL FORESTS OF CENTRAL ONTARIO

We studied the impact of forestry practices on wildlife in central Ontario by comparing population densities of spruce grouse (Canachites canadensis) in 13 jack pine and 8 black spruce forests differing in age and origin (natural, plantation). The number of grouse observed per hour with dogs was used to estimate population density since it was strongly related (R^2=.968) to total counts of residents banded in 6 intensively worked forests. The highest densities of grouse (.69-.81 birds/ha.), greater than any recorded elsewhere in North America, occurred in young (11-21 yrs.) pine plantations. Older plantations (28-62 yrs.) were not as productive ($\leq$.12-.20 birds/ha.). However one (46 yrs.) contained .63 birds/ha. There was little floristic variation among pine plantations. Density of grouse appeared to be greatest when high abundance and interspersion of low shrubs and herbs was associated with thick tree cover. Results suggest that grouse populations decrease as a pine plantation matures unless there is a substantial black spruce component in the understory.

Populations of grouse were lower ($<$.05-.30 birds/ha.) in spruce forests (19-120 yrs.). Differences between grouse density in pine and spruce forests appeared to be most strongly associated with differences in moisture regime, and concurrently, type and interspersion of low shrubs and herbs.

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THE LIMITATIONS TO PREDICTABILITY OF PLANT SUCCESSION IN NORTHERN ECOSYSTEMS

The applicability of the classical concept of succession to the northern ecosystems is questionable and so are the corresponding methods of predictions. This paper discusses the limitations of the classical concepts, illustrates the range of community changes in some of these northern ecosystems that can be recognized as successional changes, discusses the recent techniques to simulate and predict successional changes, and suggests approaches that may be used in predicting succession patterns in the future. Examples illustrating these approaches of predicting models of northern ecosystems are presented.

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Lakehead University

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FOREST MANAGEMENT ISSUES IN NORTHERN FORESTS

Chairman: Jim Kayll

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Dryness,C.T.,Norum, R., Slaughter,C.W., Van Ballenberghe,V., Viereck,L.A., Werner,R.A., Zasada, J.	Forest Management in the Taiga of Alaska - Issues for Integrated Research
Moore, T.R.	The Subarctic Woodlands of Northern Quebec
Nichols, Harvey	Climatic Change and the Boreal Forest: A Perspective for Management
Farmer,Robert E., Peggy Knowles & W.H. Parker	Genetic Resources of the North American Boreal Forest
Van Cleve, Keith and Leslie A. Viereck	Dynamics of a Black Spruce Ecosystem in Comparison to other Forest Types: A Multi-Disciplinary Study in Interior Alaska
Naylor,B.J., Bendell, J.F., and M.T. Lattner	Abundance and Diversity of Small Mammals in Mixed and Pure Jack Pine Forests
Szuba,K. and J.F. Bendell	Density of Spruce Grouse in the Boreal Forest of Central Ontario
Wetzler, Richard E.	Mechanisms of Insect Population Response to Boreal Forest Monocultures
Zackrisson, Olle	Forest Fire Elimination and its Consequences for the Flora and Vegetation of the Boreal Forest
Lopoukhine, Nikita	Parks Canada in the Boreal Forest Ecosystem
Saastamoinen, Olli	Problems of Multiple Use in Forestry in the Northern Boreal Zone of Finland

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FIRE IN BOREAL ECOSYSTEMS

Chairman: Ian Methven

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Battson, R.A. and K.B. Cawker	The Methodology Involved in the Determination of Long Term Fire Histories: An Examination of Charcoal and Pollen from Mashagama Lake, Ontario
Hawkes, Brad	Fire History and Ecology of Forest Ecosystems in Kluane National Park - Fire Management Implications
Alexander, Martin E.	Natural Regeneration after Wildfire in the Boreal Forest of Northwestern Ontario
Thomas, P.A. & R.W. Wein	The Regeneration of Trees from Seed on Burned Organic Matter in the Boreal Forest
Spires,S. & Bendell, J.F.	Immediate Effects of a Forest Wildfire on Somé Invertebrates, Small Mammals and Birds in Northern Ontario
Stocks, Brian & Roger B. Street	Forest Fire Weather and Wildfire Behaviour in the Boreal Forest of Northwestern Ontario
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NORTHERN COMMUNITIES

Chairman: Alison Gill

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Koolage, William W. and Joseph M. Kaufert	Native Canadian Interpreters Multiple Role Functions in Health Care Delivery
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Weller, Geoffrey E.	Provincial Ministries of Northern Affairs: A Comparative Analysis

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Chairman: Rick Riewe

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Boothroyd, Peter & Dennis Jaques	Effect of the Churchill River Diversion on Waterfowl Use of the Lower Churchill River, Manitoba

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CLASSIFICATION, SUCCESSION AND NUTRIENT CYCLING IN NORTHERN FORESTS

Chairmen: Alan Gordon and John Jeglum

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Wannamaker, B.A. & T.J. Carleton	An Investigation into Self Thinning and Growth of Natural Black Spruce Stands in the Clay Belt of Northern Ontario.
Wein, R.W. & M.A. El-Bayoumi	The Limitations to Predictability of Plant Succession in Northern Ecosystems
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Gordon, Andrew M.	Seasonal Patterns of Nitrogen Mineralization following Harvesting in the White Spruce (Picea Glauca (Moench.) Voss) Forests of Interior Alaska
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Chairman: Gerry Courtin

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Hogan, G.D. & D.L. Wotton	Effects of the Mining and Smelting Industry on Boreal Forest Systems: Past, Present and Future
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Jeglum, John K.	Canadian Forestry Service, Great Lakes Forest Research Centre, P.O. Box 490, Sault Ste. Marie, Ont. P6A 5M7
Jones, R.K.	Ontario Institute of Pedology, Agriculture Canada, Blackwood Hall, University of Guelph, Guelph, Ont. N1G 2W1
Judd, David A.W.	Executive Director, Association of Canadian Universities for Northern Studies, 130 Albert St., Suite 1915, Ottawa, Ont. K1P 5G4
Kaczanowski,S.	Regional Forestry Specialist, Department of Natural Resources, Box 1800, Gimli, Man. R0C 1B0
Kayll, A.J.	Director, School of Forestry, Lakehead University, Thunder Bay, Ont. P7B 5E1
King, Cheryl	Hunter & Associates, 6870 Goreway Drive, Suite 201, Mississauga, Ont. L4V 1P1
Kleinfelder, Joyce	Heritage North, South Gillies, Ont. P0T 2V0
Knowles, Peggy	School of Forestry, Lakehead University, Thunder Bay, Ont. P7B 5E1
Koolage, W.W.	Department of Anthropology, 452 University College, University of Manitoba, Winnipeg, Manitoba R3T 2N2
Lattner, Michael T.	Faculty of Forestry, University of Toronto, 203 College St., Toronto M5S 1A1
Lillycrop, Jocelyn E.	Natural Sciences & Engineering Research Council,Bldg. M-55, Rm.380, Montreal Road, Ottawa, Ont. K1A 0R6
Lopoukhine, Nikita	Ecologist, Natural Resources Division, Parks Canada, Les Terrasses de la Chaudière, Ottawa, Ont. K1A 1G2
Mann, David	Ontario Ministry of Northern Affairs, 421 Bay St., Sault Ste. Marie, Ont. P6A 1X3
Marek, G.T.	Ontario Ministry of Natural Resources, P.O. Box 97, Nipigon, Ont. P0T 2J0
Marsh, Chris	Department of Natural Resources, Kenora, Ont.
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Martin, Antonio M.	Department of Biochemistry, Memorial University, St. John's, Nfld. A1B 3X9
Maynard, D.G.	Northern Forest Research Centre, 5320-122 Street, Edmonton, Alberta T6H 3S5
McCullough, Gregory K.	Freshwater Institute, 501 University Crescent, Winnipeg, Manitoba R3T 2N6
McIlveen, William	Ontario Ministry of the Environment, 199 Larch st., Sudbury, Ont. Pe/ 5P9
Mead, Douglas A.	Staff Ecologist, Shell Canada Resources, P.O. Box 100, Calgary, Alberta T2P 2H5
Metcalfe, John	Royal Commission on the Northern Environment, Arthur Square, 215 River Road, Suite 201, Thunder Bay, Ont. P7B 1A5
Methven, I.R.	Department of Forest Resources, University of New Brunswick, Box 4400, Fredericton, N.B. E3B 5A3
Michalenko, Greg	Faculty of Environmental Studies, Department of Man - Environment Studies, University of Waterloo, Waterloo, Ont. N2L 3G1
Moore, Janice	Department of Biology, University of New Brunswick, Fredericton, N.B. E3B 5A3
Moore, T.R.	Department of Geography, McGill University, 805 Sherbrooke St. W., Montreal, Que. H3A 2K6
Mothersill, John	Dean of Science, Lakehead University, Thunder Bay, Ont. P7B 5E1
Muller, R. Andrew	Department of Economics, McMaster University, Hamilton, Ont. L8S 4M4
Naylor, Brian J.	P.O. Box 297, Gogama, Ont. P0M 1W0
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Nichols, Harvey	Department of Environmental, Population and Organismic Biology, University of Colorado, Boulder, Colorado 80309, U.S.A.
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Pierpoint, Geoffrey	Ontario Institute of Pedology, University of Guelph, Guelph, Ont. N1G 2W1
Pringle, William L.	Superintendent, Experimental Farm, R.R.8 RMD 6, Prince George, B.C. V2N 4M6
Ranta, W. Bruce	Wildlife Biologist, Ministry of Natural Resources, 809 Robertson St., Kenora, Ont. P9N 3X9
Riewe, R.R.	Department of Zoology, University of Manitoba, Winnipeg, Manitoba R3T 2N2
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Saastamoinen, Olli	The Finnish Forest Research Institute, Rovaniemi Research Station, Etelaranta 55, SF-96300 Rovaniemi, Finland
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Senyk, John P.	Environment Canada, Lands Directorate, 506 West Burnside Rd., Victoria, B.C. V8Z 1M5
Shilts, W.W.	Geological Survey of Canada, Energy, Mines & Resources, 601 Booth St., Ottawa, Ont. K1A 0E8
Silversides, C.R.	R.R.#1, Prescott, Ontario K0E 1T0
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Siuruainen, E.O.	Department of Geography, University of Oulu, Linnanmaa, SF-80570 Oulu 57, Finland
Spears, Rebecca	U.S.D.A. Forest Service, P.O. Box 308, Grand Marais, Minnesota 55604 U.S.A.
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Stoehr, Michael	Lakehead University, Thunder Bay, Ont. P7B 5E1
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Weingartner, David	P.O. Box 2960, Thunder Bay, Ont.
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Wilkinson, Paul F.	Associate Director, Research, Centre for Northern Studies and Research, McGill University, 1020 Pine Ave. W., Montreal, Que. H3A 1A2
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Winkler, J.A.	Management Forester, Abitibi-Price Inc., Lakehead Woodlands Division, P.O. Box 2510, Thunder Bay, Ont. P7B 5E9
Winsor, R.G.	Forest Resources & Lands, Government of Newfoundland, Building 851, St. John's, Nfld.
Wotton, David	Province of Manitoba
Yesno, Andy	Port Hope Reserve, Eabamet Lame, Ont. P0T 1L0
Zackrisson, Olle	Department of Forest Site Research, Faculty of Forestry, Swedish University of Agricultural Sciences, S-901 83 Umea, Sweden

ASSOCIATION OF CANADIAN
UNIVERSITIES FOR NORTHERN STUDIES

ASSOCIATION UNIVERSITAIRE
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INTERNATIONAL SYMPOSIUM
ON THE
DYNAMICS OF BOREAL FOREST ECOSYSTEMS:
FUTURE RESEARCH AND MANAGEMENT REQUIREMENTS

AUGUST 23 - 26, 1982

Lakehead University, Thunder Bay, Ont.

CHAIRMAN: Dr. Ross W. Wein, University of New Brunswick

PROGRAM OUTLINE AND LOCAL ARRANGEMENTS

The organizers gratefully acknowledge generous financial support received from the following organizations

Government of Canada
Great Lakes Forest Products
NOVA, AN ALBERTA CORPORATION
Petro-Canada
Polar Gas Project
Province of Alberta
Province of Manitoba
Province of Newfoundland
Province of Ontario
Province of Saskatchewan

130 ALBERT, OTTAWA, CANADA K1P 5G4 TEL: (613) 238-3525

INTERNATIONAL SYMPOSIUM ON THE DYNAMICS OF BOREAL FOREST ECOSYSTEMS:
FUTURE RESEARCH AND MANAGEMENT REQUIREMENTS

PROGRAM OUTLINE AND LOCAL ARRANGEMENTS

SUNDAY, AUGUST 22, 1982

	Room Registration at Lakehead University Residence	
1800-2230	Conference Registration Cash Bar, Supper	Agora, University Centre

MONDAY, AUGUST 23, 1982

0900-1230	Plenary Session	Upper Lecture Theatre
1230-1400	Lunch	Residence Dining Room
1400-1700	Plenary Session	Upper Lecture Theatre
1700-1800	Reception, hosted by Lakehead University Welcome: Mr. Grant Thompson, Vice-President	Faculty Lounge
1800-1900	Dinner	Residence Dining Room
1830-2400	Cash Bar	Faculty Lounge

TUESDAY, AUGUST 24, 1982

0900-1230	Workshops	Locations to be announced
1230-1400	Lunch	Residence Dining Room
1400-1700	Workshops	
1745,1800, 1825,1840	Buses leave Residence for Airlane Motor Hotel	
1800	Cash Bar	Airlane Motor Hotel
1900	Banquet	
2200,2400	Buses return to Residence	

WEDNESDAY, AUGUST 25, 1982

0900-1230	Plenary Session	Upper Lecture Theatre
1230-1400	Lunch	Residence Dining Room
1400-1700	Plenary Session	Upper Lecture Theatre
1800-2200	Cash bar	Faculty Lounge

THURSDAY, AUGUST 26, 1982 - FIELD TRIPS

LOCAL ARRANGEMENTS

The Symposium Office is located in the Little Dining Room adjacent to the Faculty Lounge. Please do not hesitate to contact us if we can be of assistance during the Symposium.

A Cash Bar will be available in the Faculty Lounge on:

Sunday, August 22	1800 - 2200
Monday, August 23	1830 - 2400
Wednesday, August 25	1800 - 2200

Meal hours in the Residence are:

Breakfast	0800 - 0900
Lunch	1230 - 1330
Dinner	1800 - 1900

ASSOCIATION OF CANADIAN
UNIVERSITIES FOR NORTHERN STUDIES

ASSOCIATION UNIVERSITAIRE
CANADIENNE D'ETUDES NORDIQUES

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SECOND CIRCULAR

INTERNATIONAL SYMPOSIUM ON THE DYNAMICS OF BOREAL FOREST ECOSYSTEMS: FUTURE RESEARCH AND MANAGEMENT REQUIREMENTS

AUGUST 23 - 26, 1982
LAKEHEAD UNIVERSITY

BOREAL FOREST SYMPOSIUM SECRETARIAT
ASSOCIATION OF CANADIAN UNIVERSITIES FOR NORTHERN STUDIES

I. PROGRAM

SUNDAY, AUGUST 22, 1982

Room Registration at Lakehead University Residence

1800-2030	Conference Registration Cash Bar, Supper	Agora, University Centre

MONDAY, AUGUST 23, 1982

0900-0930	Introductory Remarks and Greetings	Upper Lecture Theatre
0930-1230	CONSTRAINTS RESULTING FROM THE DYNAMICS OF BOREAL FOREST ECOSYSTEMS	

"A Physical Scientist's Viewpoint"
Dr. F.K. Hare, Provost
Trinity College, University of Toronto

"A Social Scientist's Viewpoint"
Dr. P.F. Wilkinson,
Centre for Northern Studies & Research
McGill University

"A Resource Manager's Viewpoint"
Dr. G.L. Baskerville,
Faculty of Forestry,
University of New Brunswick

"A Biological Scientist's Viewpoint"
T.B.A.

1230	Lunch	Residence Dining Room
1400-1700	POTENTIAL OF RENEWABLE AND NON-RENEWABLE RESOURCES	

"Food Production" (agriculture, fisheries, wildlife)
Dr. R.R. Riewe,
Department of Zoology,
University of Manitoba

"Fibre Production" (forestry)
Dr. G.F. Weetman,
Faculty of Forestry,
University of British Columbia

"Energy Production"(biomass, petroleum, radioactive minerals,water)
Dr. R.P. Overend,
Division of Energy Research and Development,
National Research Council of Canada

"Mineral Production"
Dr. J.M. Franklin,
Geological Survey of Canada,
Energy, Mines and Resources Canada

MONDAY, AUGUST 23, 1982 (continued)

1700-1800	Reception, hosted by Lakehead University	Faculty Lounge
1830-2400	Cash Bar	Faculty Lounge

TUESDAY, AUGUST 24, 1982 - WORKSHOPS

0900-1230	Presentations of contributed papers and discussions	Location to be announced
1230	Lunch	Residence Dining Room
1400-1700	Presentations and discussions continue	
1745,1800, 1825,1840	Buses leave Residence for Airlane Motor Hotel	
1800	Cash Bar	Airlane Motor Hotel
1900	Banquet	
2200,2240	Buses return to Residence	

WEDNESDAY, AUGUST 25, 1982 - WORKSHOP SUMMARY PAPERS

"RESOURCE CONFLICTS AND COMPATIBILITIES

0900-1230	Presentation of synthesis papers on environmental and management issues	Upper Lecture Theatre
1230	Lunch	Residence Dining Room
1400-1700	Presentations continue	
1800-2000	Cash bar	Faculty Lounge

THURSDAY, AUGUST 26, 1982 - FIELD TRIPS

See pages 4 and 5 for details

II. INSTRUCTIONS TO CONTRIBUTORS

It now appears that approximately 50 papers will be presented in the workshops. All abstracts will be distributed with the registration package at the Symposium. Since the number of presentations varies with workshops, we suggest that the oral presentations be approximately 15-20 minutes in length. The chairperson and a small committee from each of the workshops will present a summary of management and policy issues as well as high priority research which will then be presented on the following day.

At the present time, the workshops will include:

1. Northern forest fires - approximately 10 papers ranging from fire behaviour through fire effects.

2. Classification of northern forests - this is a small workshop of approximately 5 papers. The subject matter ranges from the use of satellite imagery through mathematical classification techniques for identifying landscape and forest units.

3. Succession and revegetation dynamics of northern forests - approximately 25 papers will be presented. These papers are presently grouped under one workshop but they may be divided since the subject matter ranges all the way from basic nutrient or population dynamics through to a strong orientation to management.

4. Energy from northern forests and peatlands - this small workshop includes topics both on forest biomass and peatland biomass. The subject ranges from production through to utilization.

5. Toxic substance releases in the North - this small workshop includes topics such as the effect of fallout and natural radioactivity through to localized contamination because of mining and smelting industries, through to the impact of acid precipitation over large areas.

6. Northern river diversions and impoundments - this small workshop includes environmental impacts of the large hydroelectric power developments, primarily in northern Canada.

7. Northern fish and wildlife - the approximately 10 papers submitted under this topic range from the estimates of biomass through to the use of native species through to the protection of species from over-hunting and other human influences.

8. Northern settlements - this small workshop contains papers that range from community planning through to the physical resources and the human impact in the immediate settlement areas.

9. Northern agriculture - sufficient interest has been expressed in this topic that there is a current attempt to develop a workshop. Subjects will range from the use of native species through to the introduction of conventional agriculture into more northern regions.

III. FIELD TRIPS

1. Ogoki Wilderness - Three-day Field Trip: August 26, p.m. - August 29, p.m.

Special arrangements have been made with Wild Waters Nature Tours and Expeditions to use their remote Shawanabis Lake base camp for a post-conference field trip from the evening of August 26 to the evening of August 29. The Shawanabis Lake base is accessible only by rail or float plane. Twenty-five miles west of Armstrong and 150 miles north of Thunder Bay, it is situated on the edge of the Ogoki-Albany Wilderness Area. This proposed Provincial Wilderness Park is roadless and has yet to incur any logging or mining activity.

The majority of the area has fire-created stands of black spruce or jack pine, with the forest floor consisting of dense mats of caribou lichens and feather mosses (mainly Pleurozium species) over shallow soils or bare granite shield. Also close to the camp are swamps and bogs, as well as some study areas of pockets of deeper soils. The Ogoki Wilderness is prime habitat for woodland caribou, with the resident "Elf Lake-Wabakimi" herd numbering 100-200 animals.

Accommodation will be in a comfortable log bunkhouse, with all meals supplied "family-style". Field trips will be by foot trail, or by canoe. Naturalist interpreters will include Rob Farmer of the Lakehead University Forestry Department and Bruce Hyer, Director of Wild Waters, who has been leading boreal naturalist tours for 16 years. Personal clothing and sleeping bag will be supplied by the participant. All other equipment will be supplied by Wild Waters, including compound and dissecting scope, and generator and slide projector for evening slide presentations.

Itinerary is as follows:

AUGUST 26, p.m.	Lakehead University bus will connect with VIA Rail "bush train" for ride from Nakina and/or Armstrong to Shawanabis Lake base.
AUGUST 27,28,29	Boreal field trips
AUGUST 29, p.m.	Float plane to Armstrong and Lakehead University bus return to Lakehead University in Thunder Bay.

COST:	Room, meals and use of Shawanabis Lake facilities	$135.00
	Train	15.00
	Float Plane (25 miles by Cessna 185 including aerial viewing of recent logging clearcuts near Armstrong)	25.00
	TOTAL COST	$175.00

REGISTRATION Participants will be limited to the first 20 applicants. Application and cheque made out to Wild Waters should be sent to Dr. Robert Farmer, School of Forestry, Lakehead University, Thunder Bay, Ont. P7B 5E1, prior to July 15, 1982.

INQUIRIES: Rob Farmer, Lakehead University (807) 345-2121, ext. 510 or 507
Bruce Hyer, Director, Wild Waters, R.R.#13, Lakeshore Drive, Thunder Bay, Ont. P7B 5E4 (807) 683-3151

2. One-Day Excursion to the Nipigon District - August 26

This field trip will consist of a one-day excursion to the Nipigon District of the Ontario Ministry of Natural Resources to examine forest ecosystem management practices. Participants will visit silviculturally treated areas involving: (1) stand conversions of natural trembling aspen to white spruce using cleaning and shelterwood methods, (2) rehabilitation efforts on grassland sites resulting from repeated fires, (3) plantations of young jack pine and black spruce established on cutover and burned sites, (4) intensive logging of second growth stands of balsam fir, and (5) natural regeneration of shallow-soil spruce by modified clearcutting systems.

Bus will depart Lakehead University at 0800 and return to Thunder Bay by 1730.

Tour Guide: G.T. Marek

Cost: $30.00 (including box lunch)

Those wishing to participate in this field trip are requested to forward the attached form together with payment to the Boreal Forest Symposium Secretariat, ACUNS, 130 Albert Street, Suite 1915, Ottawa, Canada K1P 5G4. Cheques should be made payable to the Association of Canadian Universities for Northern Studies.

3. Morning Tour - August 26

A morning tour of Great Lakes Paper Products Ltd. is offered to participants. Leaving Lakehead University at 0830, the visit involves a two-hour-long conducted tour through the mill operation, followed by opportunity for questions and discussion. The tour will return to Lakehead University by mid-day, and could drop some participants at the airport, if it is required.

Limit: 24 persons
Cost: $7.00

Those wishing to participate are requested to forward the attached form together with payment to the Boreal Forest Symposium Secretariat, ACUNS, 130 Albert Street, Suite 1915, Ottawa, Canada K1P 5G4. Cheques should be made payable to the Association of Canadian Universities for Northern Studies.

IV. LOCAL ARRANGEMENTS

A campus map is enclosed for your information.

Room registration at the University Residence will commence on Sunday afternoon, August 22nd. Conference registration begins at 1800, August 22nd. A cash bar, soup and sandwiches, and coffee will be available during registration.

A meal plan is available to those staying in residence at a cost of $35.00. The package will include breakfast, lunch and dinner on August 23rd and 25th, and breakfast and lunch on August 24th. Lunch will be available at the University for those staying elsewhere. Coffee will be served during the meetings, courtesy of the Symposium organizers.

Meal hours at Residence are:	Breakfast	0730 - 0830
	Lunch	1230 - 1330
	Dinner	1800 - 1900

Mr. Grant Thompson, Vice-President (Finance) of Lakehead University, will welcome participants to a reception given by the University on Monday evening, August 23rd.

The Symposium organizers invite participants to be their guests at the banquet on Tuesday evening, August 24th.

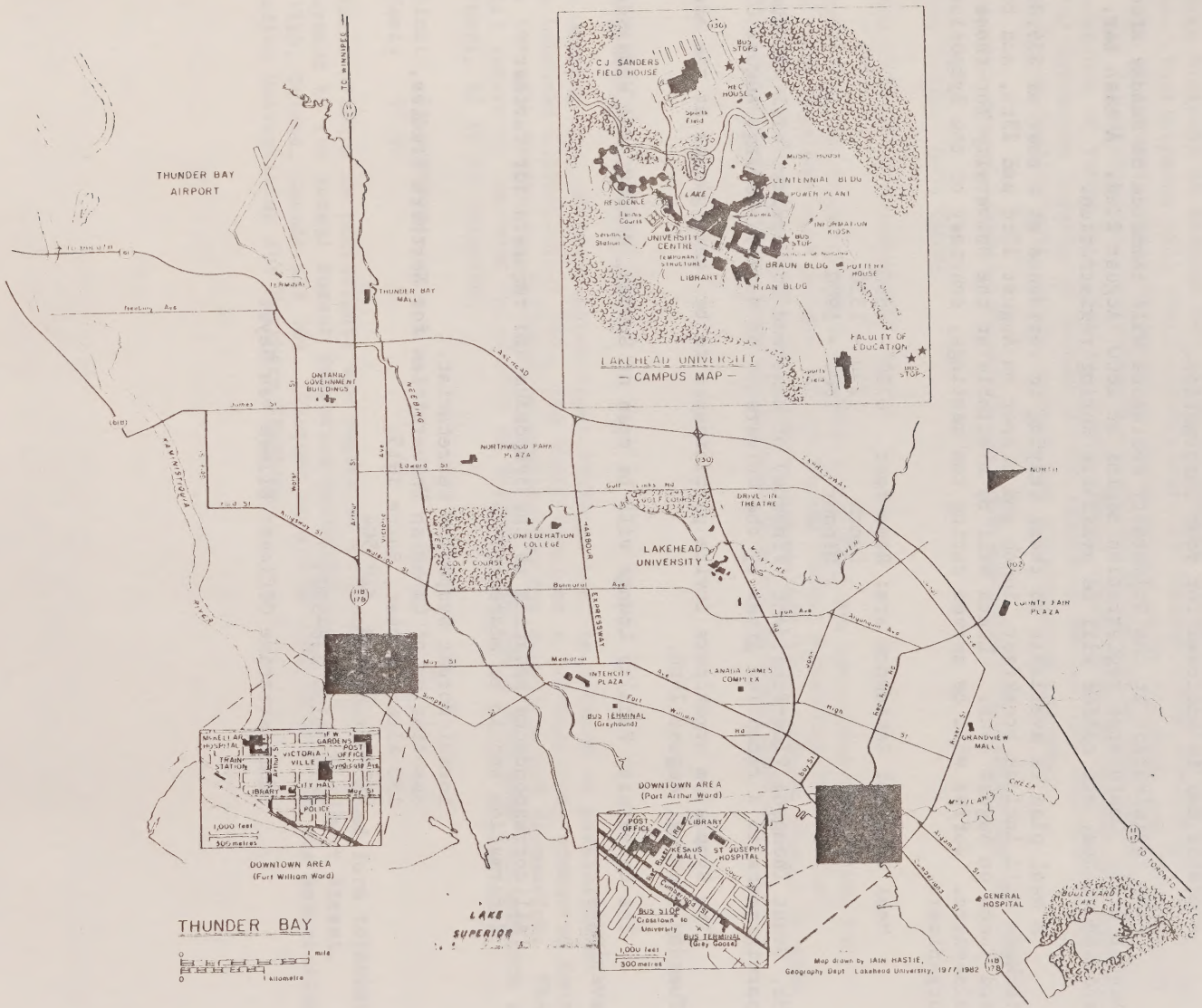
The University Faculty Lounge will be open on Sunday, Monday, and Wednesday evenings.

All correspondence relating to the Symposium and requests for further information should be addressed to:

Boreal Forest Symposium Secretariat,
Association of Canadian Universities for Northern Studies,
130 Albert Street, Suite 1915,
Ottawa, Canada K1P 5G4

Tel: (613) 238-3525

Administrative Officer: Eileen van Heyst


LAKEHEAD UNIVERSITY
— CAMPUS MAP —
C.J. SANDERS FIELD HOUSE
REC HOUSE
CENTENNIAL BLDG
POWER PLANT
RESIDENCE
UNIVERSITY CENTRE
INFORMATION KIOSK
BUS STOP
TEMPORARY STRUCTURE
LIBRARY
BRAUN BLDG
POTTERY HOUSE
RIAN BLDG
FACULTY OF EDUCATION
THUNDER BAY AIRPORT
THUNDER BAY MALL
ONTARIO GOVERNMENT BUILDINGS
NORTHWOOD PARK PLAZA
CONFEDERATION COLLEGE GOLF COURSE
LAKEHEAD UNIVERSITY
DRIVE-IN THEATRE
COUNTY FAIR PLAZA
INTERCITY PLAZA
CANADA GAMES COMPLEX
BUS TERMINAL (Greyhound)
UNANDVIEW MALL
GENERAL HOSPITAL
DOWNTOWN AREA (Fort William Ward)
McKELLAR HOSPITAL
VICTORIA VILLE
TRAIN STATION
POST OFFICE
CITY HALL
LIBRARY
POLICE
1,000 feet
300 metres
DOWNTOWN AREA (Port Arthur Ward)
POST OFFICE
LIBRARY
KEESAUS MALL
ST JOSEPH'S HOSPITAL
BUS STOP Connection to University
BUS TERMINAL (Grey Goose)
LAKE SUPERIOR
THUNDER BAY
1 mile
1 kilometre
NORTH
TO TORONTO
TO WINNIPEG
Map drawn by IAIN HASTIE, Geography Dept Lakehead University, 1977, 1982

In the past decade there has been a burst of research and other scholarly activity in the North due to the location and development of mineral and petroleum resources. Relatively little research and scholarly activity has taken place recently in the boreal forest, yet the boreal forest is as wide as 1000 km. in areas of North America and Eurasia. Roughly two-thirds of the boreal forest is located in Eurasia. In Canada, the zone occupies one-third of the land mass and involves both provincial and federal jurisdictions.

In August 1969, a Mid-Canada Development Conference was held at Lakehead University, Thunder Bay, to examine the development potential of the boreal forest. Since this conference there has been no major interdisciplinary conference to stimulate research, training, and other scholarly activities. It is hoped that the 1982 symposium will lead to such activities.

The objective of this symposium is to bring together scientists, policy-makers and managers to stimulate information exchange on how the boreal forest ecosystem functions, to identify what research information is needed, and to determine how policy and management programs must operate within the constraints of the ecosystem.

The symposium is designed in three distinct parts. Part 1 dealing with the constraints on northern development will provide four overviews of the situation, seeking to identify in broad brush-strokes the constraints on policy and management brought about by the dynamics of the boreal forest ecosystems. This part is designed to form a basic framework for subsequent papers and discussion.

In Part 2, workshops will seek to elicit specific knowledge, identify knowledge gaps, and give an opportunity for the presentation of detailed papers resulting from current research and management issues.

The third part of the symposium will be an opportunity to pull together the knowledge shared in the workshops and specifically to identify management and policy issues or gaps in knowledge.

The final products of the symposium will be (a) a scholarly volume of scientific papers on the state-of-our-knowledge prepared by speakers and subjected to the external peer review process; (b) a report on management and policy issues which will result from a workshop format; and (c) a report on directions of high priority research which also will result from a workshop format.

PROGRAM

Monday, August 23, 1982 — Keynote Speakers

"Constraints resulting from the dynamics of boreal forest ecosystems"

Dr. F. Kenneth Hare,
Provost, Trinity College,
University of Toronto
"A Physical Scientist's Viewpoint"

Dr. Paul F. Wilkinson,
Centre for Northern Studies & Research
McGill University
"A Social Scientist's Viewpoint"

Dr. Gordon L. Baskerville
Faculty of Forestry,
University of New Brunswick
"A Resource Manager's Viewpoint"

T.B.A.
"A Biological Scientist's Viewpoint"

"Potential of Renewable and Non-renewable Resources"

Dr. R.R. Riewe,
Department of Zoology
University of Manitoba
"Food Production" (agriculture, fisheries, wildlife)

Dr. G.F. Weetman,
Faculty of Forestry,
University of British Columbia
"Fibre Production" (forestry)

T.B.A.
"Energy Production" (biomass combustion, petroleum, radioactive minerals, water)

T.B.A.
"Mineral Production"

2000-2300 — Meeting
Association of Canadian Faculties of Environmental Studies (ACFES)

Tuesday, August 24, 1982 — Workshops

"Future Environmental and Management Issues"
Human settlements
Acid precipitation
Basin-to-basin water transfers
Species and landscape protection
Wildlife population protection & control
Biomass energy from forest & peatlands
Forest fire management
Sustained fibre production from forests/management of mixed forests
Heavy metal release
Radioactive material release

Evening — Symposium Banquet Airlane Hotel

Wednesday, August 25, 1982 —

Workshop Summary Papers
"Resource Conflicts and Compatibilites"
Presentation of synthesis papers on environmental and management issues

Thursday, August 26, 1982

Field Trips — details will be announced in the second circular

On Monday, August 23rd, the invited keynote speakers will present papers to the full symposium. On Tuesday, August 24th, the environmental and management issues will be addressed in separate sessions where a lead-off paper will be followed by contributed papers. Chairpersons from each of the sessions will prepare a summary to be presented on Wednesday, August 25th. It is intended to give ample time for discussion of the state-of-the-art and future research requirements.

NOTICE TO AUTHORS

Persons wishing to present a paper on topics given under the Program Schedule should advise the Symposium Secretariat as soon as possible, including the full title, names, addresses and telephone numbers of the author(s). Details concerning the format for abstracts will be forwarded immediately. **Deadline for the submission of abstracts is May 15, 1982.** The language of the Symposium will be English.

ASSOCIATION OF CANADIAN UNIVERSITIES FOR NORTHERN STUDIES

The Association of Canadian Universities for Northern Studies (ACUNS), which is sponsoring the symposium, was founded in Churchill, Manitoba in 1977 and incorporated in 1978. The purpose of the Association is the advancement of northern scholarship through education, professional and scientific training, and research. Thirty-three Canadian universities are currently members of ACUNS, and it is through these member universities that approximately 800 northern scholars can present their views.

CONFERENCE FEES

Registration fees will be $50.00 per person. To encourage student attendance, their registration fee will be $5.00. A small travel budget will be made available to partially support overseas travellers, travellers from northern settlements, and travel by undergraduate and graduate students who will be contributing papers. Requests for assistance should be addressed to the Symposium Secretariat. Registration is by mail and must be received by **June 25, 1982.**

ACCOMMODATION AND TRANSPORTATION

Accommodation will be available at Lakehead University Residence Buildings at an approximate cost of $15.00 per night, single occupancy, $12.00 per night double occupancy. Meals will be served in the Residence Dining Room. Residence accommodation should be reserved through the Symposium Secretariat.

Hotel accommodation is also available and participants are asked to make their own arrangements. A listing of hotels is available from the Symposium Secretariat. Participants are advised to make reservations before the summer tourist season commences.

Air, rail, and bus services provide transportation to Thunder Bay.

Air — Air Canada and Nordair
Rail — Via Rail
Bus — Greyhound and Greygoose